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THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

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EMPIRE FORESTRY.

THE editorial article in *Nature* for 11th June, 1932, discusses colonial forests and their staffs. Tropical agricultural administrators at the present time are eagerly seeking alternative resources, and in many cases, are faced with the necessity of revising their broad agricultural policies. Hence, it might be useful to present here for serious consideration, some points abstracted partly from the editorial to which reference has been made, and certain other points which have more technical bearing on the subjects raised.

Following the First Empire Conference of Prime Ministers which was held in London, a Forestry Sub-Committee was appointed to consider the method by which a forest policy might be formulated, applicable alike to the different Colonies. The reports and memoranda issued by the Sub-Committee are mainly concerned, however, with the question of self-sufficiency in the supply of timber within the Empire, and with the prospects of developing further the export markets for Imperial tropical forest products. The protection and proper management of tropical and sub-tropical forests unfortunately was not so thoroughly stressed, although later they formed a subject for discussion at the Oxford (1926) meeting of the British Association, which resulted in a special memorandum drawn up by Lord Clinton, Chairman of the Forestry Sub-Section. The Clinton memorandum was subsequently submitted to the Secretary of State for the Colonies, and afterwards communicated by him to the Governors of Protectorates and Colonies, so that the main facts should now be widely known.

The chief deleterious practices to which many tropical forests are exposed are shifting cultivation, annual firing and excessive stock grazing. No doubt every colonial administrator is fully aware of the damage which these practices produce, but, we may add, little appears to be known concerning the actual processes of recovery which many damaged forest areas may experience naturally, or which may be initiated by proper silvicultural operations. Much scope for research and experimentation in tropical forest soil degeneration and regeneration exists, for new rapid methods of soil examination are becoming increasingly available, and merely await application to specific forestry problems.

Perhaps the main drawback to rapid progress in knowledge of forest management, of forest growth conditions, and of forest soil processes is

the lack of adequate staff in the various colonial Forestry Departments. Immediately after the War, the Colonial Office commenced to recruit trained men for forest services in the Dependencies, and thus took definite steps to grapple with the local problems. The real need for effective forest management and conservation was evidently well recognised, but it is doubtful whether effective action in every Colony has actually been taken, and sufficient staff recruited to cope with the various problems requiring solution. Recent financial stringency unfortunately has caused many Government administrations and commercial organisations to reduce the number of forestry posts and to curtail recruitments. This policy, although perhaps effective in helping to balance Forest Department budgets, may be regarded as definitely unsound, particularly in the case of a Colony possessing capital in the form of undeveloped forests subject to abuses and suffering deterioration. For instance, probably few cases occur where the practice of shifting cultivation has been appreciably diminished during the past twenty years.

In an article on "Forests and the Economic Crisis" (*Empire Forestry Journal*, 1931, No. 2) Sir Roy Robinson expresses the opinion that "if forestry has proved an easy subject for drastic cuts, it is because it had not made sufficient friends ; . . . our educational effort has not yet borne the desired fruits." Although, apparently applied to British forestry, these remarks are particularly poignant in the case of the Colonies where an educated public opinion is practically non-existent, and where the question of forest conservation is all the more important because of the occurrence of vast areas of undeveloped forest growths. To quote *Nature* "the fact remains that, in spite of the full recognition given to the importance of putting a stop to the destruction of tropical forest, a step which is only possible by having a strong Forest Department in the Colony, and backing it up with full official authority, forest staffs are actually being reduced in a most drastic fashion and recruitment stopped. In other words, . . . the development of the capital resources of a Colony are being put back by a decade, whilst parts of the capital are subject to annual depreciation". The case of British Honduras is quoted, perhaps as an extreme case. Mahogany has been exported there for several centuries, but it was not until 1922 that a Forestry Department was created. The Department made considerable headway, but, owing to decreasing forest revenue, the unofficial members of the Legislative Council signed a petition in January, 1929, asking for general curtailment of the forestry programme and reduction of Forest Trust Expenditure. (*Report of the Forest Trust, British Honduras*, 1930. Belize, 1931.) The petition was submitted to the Secretary of State for the Colonies (Lord Passfield). His reply (quoted extensively in *Nature*) indicates that, although His Lordship "is convinced that the present structure of the Forest Department is heavier than the Colony's economic framework can sustain", yet, "at the same time he is unalterably opposed to any amendment of the legislation governing the constitution, finance, and duties of the Forest Trust", and observes that "the solution of the present financial difficulty is to be sought, not by altering the status of the Trust, but by curtailing its activities and consequent expenditure to the minimum consistent with the discharge of its routine duties, the preservation of its records, and the maintenance of the valuable experimental work already in hand". In consequence of these orders, several officers of the staff were transferred elsewhere, promising experimental work was discontinued, and the opening up of considerable areas of unknown forests was postponed.

Whilst congratulating Lord Passfield on his firm stand in this matter, *Nature* points out that "until it is recognised that a temporary fall in revenue in the case of inadequately staffed Forestry Departments should not be met by cutting down expenditure, staff, and so forth, no efficient or rapid progress can be made in the development of potentially rich but imperfectly known forest areas; whilst the delay in introducing an efficient check on indiscriminate acts of destruction is yearly reducing the value of this often irreplaceable asset" and "it appears obvious that if production, marketing and research are to be efficiently co-ordinated, the first step is to go to the fountain-head, and maintain or appoint a forest staff of sufficient strength to manage effectively the tropical forest areas in the several Colonies".

It would appear to us from these observations that much remains to be done in the direction of further publicity of the aims, objects and methods of the forestry officer trained along modern lines. Every opportunity should be accepted for educating the lay-man in the broad outlook and methods of local Forestry Departments. On the surface, sound forest policy might appear to be over-cautious, and to offer advantages only to be realised in a far too distant future. The drawback that the "forest crop" requires a relatively very great period of time to come to maturity, fails to inspire many who are concerned in agricultural matters relating to short-time crops. The overwhelming fact remains, however, that many tropical lands comprise soil-types so intrinsically poor through excessive natural leaching that they are suited only to the production of timber, and should never be considered in any other relation. Herein would appear to be another plea, namely, that more use might be made by Forestry Departments of the services which the soil ecological investigator and the soil surveyor might render. Such would be particularly valuable in the study of problems of forest regeneration and the production of new and more profitable types of forest on land already occupied by indigenous growths, for the link between agriculture and forestry practice requires firmer welding.

NATIVE BEE-KEEPING IN TANGANYIKA.

By W. V. Harris, M.Sc., A.I.C.T.A., F.Z.S.,
Assistant Entomologist, Department of Agriculture, Tanganyika Territory.

It is usual to find in statistics of bee products that only the figures for honey production are given, and that wax receives little or no mention. Yet in tropical Africa, particularly Tanganyika Territory, Belgian Congo and Angola, beeswax is an important export product.

Tanganyika's exports of beeswax since the War have been as follows :—

1923	6,039 cwts. valued at	£24,743
1924	8,497	44,666
1925	5,858	42,755
1926	6,147	48,179
1927	11,169	80,863
1928	9,815	71,079
1929	6,721	48,149
1930	3,773	20,297
1931	12,143	47,010

It will be seen that the production during 1931 is a record for the post-war period, although the fall in price has brought the total value down to the average level. A native product which can keep up to average value, by an increase in production over the previous year in spite of a continued fall in price, is worthy of consideration.

Apiculture in Tanganyika largely consists in the collection of honey and wax from wild nests, or from simple hives set up in the bush. "Honey hunting" is more suggestive of the conditions as they actually exist. Few, if any, districts are without bees. Most tribes have some old men who obtain honey for their village by professing a knowledge of bee lore, their main qualification usually being an indifference to bee stings. The areas which produce honey and wax in sufficient quantity for trade are more limited. The production of wax as an indication of bee-keeping activity is shown on the map (Fig. 1). The density of the spotting represents the relative production. A considerable amount of wax and honey is obtained from nests in hollow trees and rock clefts. In some districts, baobab trees (*Adansonia*) are numerous, and nearly all contain bee colonies. The primitive bee hunter locates a colony in a hollow tree, and towards evening builds a smoky fire at the foot of the tree. As the bees become stupified, smouldering branches are held near the entrance to the nest. The hole is then enlarged with an axe or knife, and the comb removed. In some cases, particularly in trees

Fig. 1. *Map of Tanganyika Territory showing the Beeswax Areas.*

conveniently near a village, a second hole is made beneath the first so that the smoke will penetrate quicker, and if all the comb is not removed, bees will reoccupy the nest quickly. It is not unusual for a tree to be cut down if the comb is some distance inside, and if the colony is believed to be a large one.

Native Hive Types.

Bee-keeping proper begins with the making of hives, so that bees will build their nests in convenient places, and the labour of locating wild colonies in hollow trees is obviated. Six types of hives are known, all of which reproduce the conditions of the hollow tree in a similar way to the hollow clay tube of the Egyptian peasant.

(1) A log hollowed out by fire from both ends, the ends then being closed again by a piece of bark, clay or a bung of dried grass.

(2) A log hollowed out by an axe after having first been split longitudinally. The ends are not cut away, but contain small holes to serve as entrance for the bees. When the two parts have been hollowed out, they are placed together and held with bark rope. Comb is removed by separating the two parts of the hive.

(3) A piece of the bark of trees of the genus *Brachystegia* is cut, then bent into a cylinder, and the edges secured by three or four wooden skewers. The ends are closed by circular pieces of bark held in position by diagonal strips of wood.

(4) A cylinder is made of the soft inner bark of *Brachystegia*, which is pliable when moist, and can be sewn with bark cord. It is possible to make much wider cylinders by this method. The ends are closed by circular pieces of bark, to which plaited straw is sewn to make a tight joint. The hives are well thatched with grass to protect them from the sun and rain.

(5) In Bukoba, a cylindrical hive is made by covering a framework of light bamboo sticks with a thick layer of dried banana leaves. Circular pieces of wood at the ends ensure rigidity, and a light but strong hive is obtained.

(6) Cylinders of woven grass are utilised by the Watusi in the west of the Territory. They are similar to (4) above.

Bee-hives are either supported in the branches of suitable trees, or suspended from branches by means of wooden crooks. All sewn bark and woven hives are suspended, and, in the north in particular, the hollow log hives are suspended too. In the north and among the Wagogo of the Central Province, it is not unusual to see ten or a dozen hives hanging from one baobab tree. Hives are placed singly in other localities.

Processing of Wax and Honey.

The honey comb is collected in a manner similar to that described above in the case of hollow trees, no matter which type of hive is used. There is a Swahili proverb which says that all the thanks a bee gets is fire. Real bee-keepers have however been found, particularly in Tabora, who preserve the swarms as far as possible. Among some tribes, special wood is used which produces a smoke of a particularly stupifying nature, and enables the comb to be removed without driving off all the bees.

The real danger to the colony, it is considered, does not lie in the risk of killing off the adult bees by smoking, but in the fact that brood is considered a great delicacy by most tribes. This is soon appreciated by anyone who has tried to stress the "humanitarian" aspect of brood preservation in propaganda work with double-chambered hives. The desire for brood as a food is quite an important factor in native bee-keeping.

The comb having been removed from the hive, it is divided into three portions, according to its contents. Comb containing brood is chewed till only wax remains. Honey comb is heated in a pot (Fig. 2) until the honey runs out easily when squeezed by hand (Fig. 3). The empty comb is mixed with the residues of the brood comb and the honey comb, and is melted in a pot with a little water. When liquid, the whole is filtered through a long stocking-like bag of woven grass, pressure being applied by two flat sticks (Fig. 4). As the wax cools on the surface of the water, it is removed by hand and moulded into balls. This may be taken as the standard method. The more primitive wax hunters separate the wax from the water after melting, by pouring the mixture into a hollow in the ground. The wax solidifies on the surface, while the water runs away. This is a wasteful method, and leads to the incorporation of a considerable amount of earth in the wax balls. In more enlightened districts, the wax is melted a second time with clean water, and filtered through a piece of coarse cloth. The usual mould for clean wax is an enamel basin. The value of wax varies according to the amount of rubbish incorporated in it.

A collector is shown in Fig. 5 returning with his wax in the bark box in front, and honey in the pot behind.

Wax.

Bee activity, as indicated by wax production, is subject to great fluctuation from year to year. The annual export from 1923 to 1931 is represented graphically in Fig. 6. Similar fluctuations are to be found in the German records.

In the tropics where the minimum temperature is rarely near the dormant point for vegetation, rainfall is the governing climatic factor. The rainfall for Kahama (a station near the centre of the Tabora wax area) is graphed as indicative of the climatic conditions under which the great proportion of the wax is produced. It will be seen that a striking correlation exists between the wax production and the rainfall of the preceding year. It would therefore appear that, since most of the rain in the year falls before the wax harvest, the effect of increased rainfall is to increase the swarming powers rather than the actual amount of wax produced, and that there are in consequence more colonies available to survive the bush fires and drought of the following dry season.

NATIVE BEE-KEEPING IN TANGANYIKA

FIG. 2.—*Melting the honey comb.*

FIG. 3.– *Extracting honey.*

NATIVE BEE-KEEPING IN TANGANYIKA

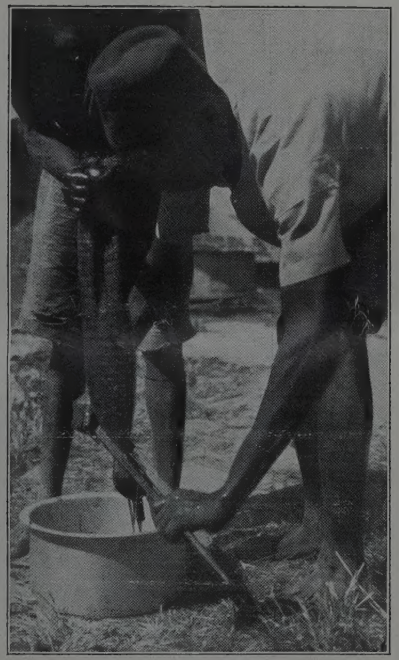

FIG. 4.—*Straining wax.*

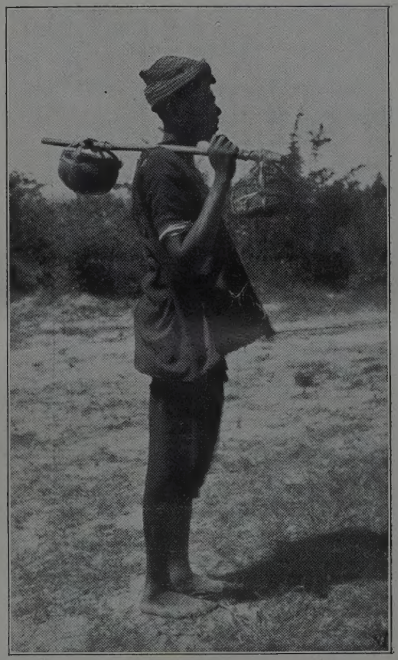

FIG. 5.—*Native returning with wax and honey.*

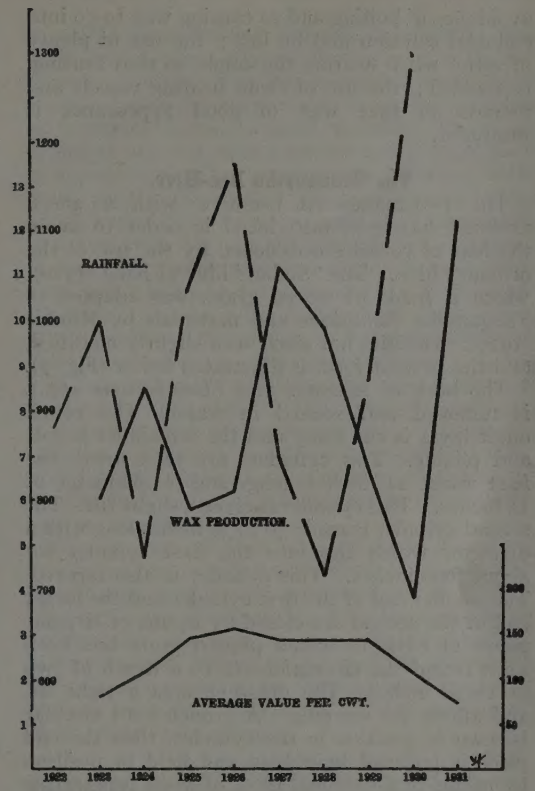

FIG. 6. *Beeswax exported from Tanganyika compared with the average value per cwt., and the rainfall of a typical station.*

Tabora beeswax (which is the trade name for the wax produced in the west and north-west of the Territory), is very uniform in colour, being a deep raw sienna. Wax from other localities is usually paler, approaching straw-yellow or even a shade resembling the colour of tallow. One specimen of chocolate-coloured wax was obtained from the Rovuma River area. It has been found at the Morogoro Laboratory that the colour of wax obtained from the hives varies with the time of year.

Honey.

There is a considerable trade in honey from the Tabora bee areas among the large native populations of the towns of Tabora, Ujiji and Mwanza. On Kilimanjaro, large numbers of bees are kept almost exclusively for the honey they produce, as the natives do not bother with wax preparation, the price obtained for honey among the Masai of the plains being a sufficient recompense.

Tanganyika honey varies in colour from pale golden-yellow to deep brown. Due to over-cooking, the honey produced by the native is frequently watery and dark. Cold-pressed honey, however, has a fine aroma and a thick consistency. From the wide range of vegetation and climate encountered, a considerable variation in honey is to be expected. There is in general a fair loss of water by evaporation during ripening. Granulation in most samples examined has been slow.

The effect of the nectar-yielding plant on the honey produced is well realised by most native bee-keepers. Mango honey is very good. Honey gathered in the bush at the time of flowering of the *Brachystegia* has an excellent flavour; it is dark in colour, very thick in consistency, and is in great demand for beer-making. The Ceara rubber tree, *Manihot glaziovii*, is very detrimental to honey production, as the flavour imparted during the flowering season is so bitter that the honey is quite uneatable. Fortunately, the area under Ceara rubber is now small and rapidly decreasing, but there still remain many areas on the Central and Northern Railways where honey production is impossible, except during a very short period before the rubber comes into flower. Ceara does not occur in the main wax areas. The small weed *Lactuca capensis* (Compositae) is also reputed to make honey bitter.

Honey is mixed as a flavouring with rice, maize or other food. Its main use however is as an ingredient of a beer (*kangara*) which is widely distributed, although in many areas legally forbidden. It is made by adding honey to the strained liquid obtained by boiling maize-bran with water. The mixture is kept warm for a day or two, when fermentation occurs. Honey is also added to the different local beers to increase their efficiency. A particularly potent spirit called *moshi* is made in the west by the distillation of *kangara*. A clay jar with a sealed top is used as a still, with a long bamboo rod as condenser. Owing to the homicidal tendencies of *moshi* addicts, the penalty for distilling is severe, but the temptation is great.

Honey is also used mixed with herbs and decoctions of bark in native medicines. Among the Wanyamwezi of Tabora Province, honey is a specific for eye troubles.

Races of Bees.

The honey bees of Tanganyika have been identified as *Apis mellifica unicolor*, Latr., and its two races, *intermissa*, Butt-Reep., and *adansoni*, Latr. The distribution of these races has been given (Harris, 1931), and may be summarised as follows, incorporating new locality records:—

Unicolor is restricted to the mountains of the north-east; *intermissa* occurs in the mountains of the north-east and the south-west, also in Bukoba to the west of lake Victoria; *adansoni* is found in practically every district in the Territory. The typical sub-species, *unicolor*, is rather smaller than the English bee; it is black, with the dorsal surface of the abdomen practically hairless. *Intermissa* is dark-coloured, with narrow bands of paler hairs on the abdomen. *Adansoni* has an abdomen orange-yellow with black bands, the proportion of the colours varying in different specimens.

Unicolor is found in Madagascar and adjacent islands. *Intermissa* is recorded from the Levant, West Africa and Nyasaland (Stitz & Szabo, 1932). Either because of the lower temperature consequent on the elevation at which they are found in Tanganyika, or because of inherent character, these two bees are moderately docile. *Adansoni* is found throughout Africa. It has a reputation of being a mild-tempered bee in both North and South Africa. This cannot be said of it in Tanganyika. Temperature appears to have some influence on the fierce temper of *adansoni* in this Territory, most complaints being caused by colonies whose nests are exposed to the direct heat of the sun for some part of the day. The worst feature of the *adansoni* temper is that attack is usually unprovoked. Nevertheless, it is this sub-species alone which has been found in the wax-producing areas, and therefore the one to which attention is directed so far as native apiculture is concerned.

Extension Work.

Extension work in bee-keeping is carried out by the Department of Agriculture on the following lines :—

1. The encouragement of bee-keeping in areas where no wax is as yet exported, by demonstrating that wax has a market value.

2. Improvement in the methods of wax preparation, where the industry is already in practice.

3. Improvement in the type of hive used, in areas of intensive wax production.

Improvement in methods of wax preparation follow the lines already suggested by the writer (1931-32). These in brief are :—the general use of woven grass bags for filtering the wax ; the avoidance of boiling and so causing wax to go into colloidal solution and be lost ; the use of plenty of water when heating the comb, so that burning is avoided ; the use of clean heating vessels and moulds so that wax of good appearance is produced.

The Tanganyika Bee-Hive.

The two-chambered bee-hive with a queen excluder has been introduced in order to avoid the loss of colonies occasioned by the use of the ordinary hive. The ' Sudan ' hive of King (1920), which is made of woven grass, was adapted to Tanganyika conditions and materials by Ritchie (1929). The hive has since been slightly modified, and the present form is illustrated below (Fig. 7).

The bark of Miombo tree (*Brachystegia spp.*), is removed and soaked in water. The rough outer layer is cut away and the remainder is soft and pliable. Two cylinders are then sewn, the first about 24 inches long and a diameter of 12 inches. This cylinder is given a slight tilt. The second cylinder is made 30 to 36 inches long with a diameter which fits into the first cylinder for about four inches. This cylinder is also tapered. The smaller end of the first cylinder and the larger end of the second are closed by means of circular pieces of bark, to which plaited grass has been sewn round the circumference to a depth of two or three inches. The grass ensures a tight fit, and allows for warping. A branch bent circular is sewn in position in the cylinder, then the end piece is jammed in tightly and held in position by means of a diagonal piece of wood penetrating the walls of the cylinder. A piece of perforated zinc supplied in nine inch circles, the perforations just permitting the worker bee to pass, but not the queen, is sewn to a rim of bark. This rim has

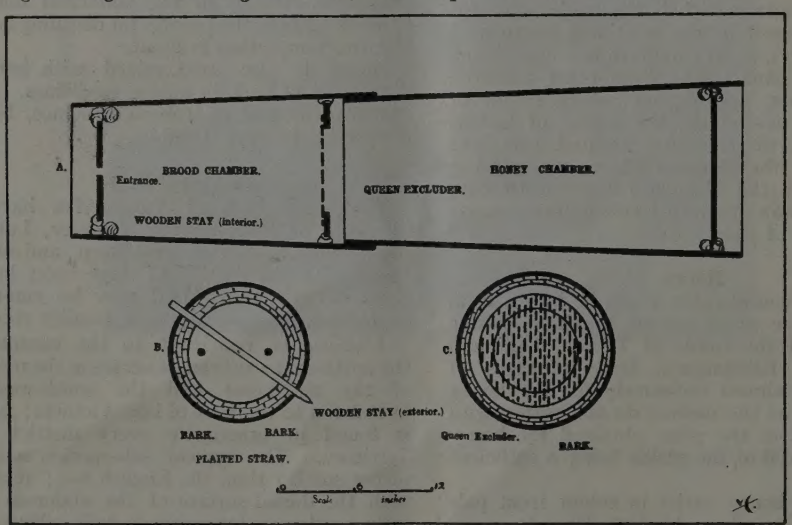

FIG. 7. *The Tanganyika Beehive.*
A.—*Section of hive assembled, but without thatch covering.*
B.—*Front end.*
C.—*Queen excluder, showing method of attachment.*

a plaited grass border and fits tightly into the short cylinder just beyond the junction with the second cylinder. Two three-quarter inch holes are punched in the end piece of the smaller cylinder as entrance holes. Placed together, the two cylinders are not unlike the ordinary pipe hive in appearance. They are securely thatched with grass, separately, so that the hive can be taken apart, bound to a long spar, and then suspended in a tree with a slight tilt towards the entrance. It has been found useful to make three or four very small holes in the rear end for ventilation purposes. During a big honey flow, these holes may be enlarged by the bees to form an additional entrance to the rear or brood chamber.

When comb is to be collected, the hive is lowered to the ground at night. The larger rear cylinder is detached, and the comb cut out. The empty cylinder is replaced, and the hive returned. The brood being confined to the front chamber, is undisturbed, and the colony carries on without loss or interruption.

By the use of this type of hive, a native bee-keeper ensures occupation of his hives occupied by colonies, and the wasteful methods of "honey hunting" are eliminated. The hive has been extensively adopted in one of the Sleeping Sickness areas where it is hoped to discourage the collector roaming the infested bush in search of bees by giving him more or less permanent hives near his village.

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BOOKS PRESENTED.

We have to acknowledge with thanks the receipt of the following books which have been presented to the Library :—

Chemistry.

Bolam, T. R.—The Donnan equilibria. *G. Bell & Sons, Ltd.*, London, 1932. 9*s.*

Entomology.

Sanderson, E. D. and Peairs, L. M.—Insect pests of farm, garden and field. 3rd edition. *Chapman & Hall*, London, 1931. £1 11*s.* 0*d.*

General.

S. A. Sugar Year Book and General Directory. *South African Sugar Journal*, Durban, 1932. 5*s.*

Statistics.

Tippett, L. H. C.—The methods of statistics : an introduction mainly for workers in the biological sciences. *Williams & Norgate Ltd.*, London, 1931. 15*s.*

YELLOW FEVER IN WEST AFRICA.

In 1900, the American Yellow Fever Commission reached the conclusion that yellow fever is transmitted only by the bites of the mosquito known as *Stegomyia fasciata.* That finding has been justified by experience, but there is now reason to suppose that other types of mosquitoes are capable of playing the part of agents of infection. In a communication to the *Lancet,* Professor Edward Hindle recounts a series of observations and experiments which have led him to the opinion that in those areas of West Africa where yellow fever is endemic, anti-mosquito campaigns should be directed against all mosquitoes indiscriminately. Yellow fever in all probability has its source and original home in West Africa, and the conditions in which it occurs in that country suggest that extensive endemic areas exist. In these areas the fever may occur in a form so different from its classic manifestation as to escape recognition.

Professor Hindle's experiments show that infected mosquitoes remain infected till they die, but do not bequeath their infection to their offspring. He has established further that the period when the victims of yellow fever are most dangerous, in the sense that they are most likely to infect mosquitoes, is the very early stage of their illness before serious signs have manifested themselves. This fact is a new justification of the method of prevention which makes the destruction of mosquitoes its chief, if not its sole, object. No doubt the sick ought to be isolated so that mosquitoes cannot reach them, but, since the blood ceases to be infective early in the disease, such precautions are probably of less value than has formerly been supposed. The ideal is a condition of affairs in which no mosquitoes are present. Conditions in West Africa are not such as to encourage the hope that yellow fever will be stamped out there in the near future. Happily vaccine and immune sera are now available for the protection and treatment of persons in immediate danger. But, if the new knowledge is applied faithfully over a period of years, the scope of the disease ought to be materially restricted.—(*The Times, Weekly Edition,* Vol. LXV, No. 2, 806.)

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We have to acknowledge with thanks the receipt of the following plant materials which have been presented to the College Department of Agriculture.

Seeds of *Prosopis juliflora* (Algaroba), *Gliricidia sepium*, *Melinis minutiflora*, and Venezuelan black bean, from the U.S.A. Department Station at Mayaguez, Puerto Rico.

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Stools of P.O.J. 2725 sugar-cane from the St. Augustine Experiment Station, Trinidad.

Six unit strains of *Cajanus indicus* (Pigeon Pea) from the University of Hawaii.

THE CACAO INDUSTRY OF TRINIDAD.

SOME ECONOMIC ASPECTS.

Part V. Section I.—Historical 1921 to 1932.

By C. Y. Shephard.

The cacao planters of Trinidad, at the end of 1920, were able to look back with great satisfaction over a period of fifty years of unbroken prosperity. They interpreted the exceptionally high prices of 1920 as the promise of an era of untold wealth. Their illusions were shattered by the sudden and precipitous fall in prices during 1921. Thus, Trinidad plantation cacao, at store Port-of-Spain, had averaged $23.92 (£4 19*s.* 8*d.*) a fanega from July 1919 to June 1920, but realised only $10.00 (£2 1*s.* 8*d.*) during the next twelve months (14). These changes in price were caused more by factors of world-wide scope, than by features peculiar to the cacao industry. Nevertheless, important changes had taken place in the industry. As long as high prices had been maintained, these developments had received scant attention, but in 1921 they were thrown into vivid relief.

The modifications in the general situation have already been outlined (30), and therefore need only brief recapitulation. The most striking feature was the enormous expansion of world exports, which rose from an average of 228,000 tons during the five-year period 1909 to 1913, to 394,000 tons in 1921 (7), (17). There had also been a remarkable change in the relative importance of "fine" and "ordinary" types of cacao. Thus, whereas "fine" types represented more than 40 per cent. of the total exports during the five year period 1909 to 1913, they accounted for only twenty-seven per cent. in 1921 (17). "Fine" types no longer constituted the basis of most cacao products, but were added, in small quantities only, to improve the flavour of the "ordinary" types.

The heavy fall in price did not result in an immediate reduction of production; on the contrary, exports continued to rise rapidly and reached 506,000 tons in 1924 (7). The causes of this expansion were varied. The effect of the neglect of cacao cultivation is not an immediate and heavy reduction of yield, but a steady decline spread over a number of years. Many cacao planters were able to secure an income at the expense of future productivity by severely curtailing their expenditure on cultivation. They abandoned their properties only when yields had declined to such an extent that the possibility of obtaining profits had permanently ceased. Consequently, even where the price of cacao was less than the normal cost of production, neither the area under cultivation, nor the production of cacao was appreciably reduced.

On the other hand, the exceptionally high price realised for cacao immediately after the War had encouraged widespread planting. A cacao field normally takes about five years to reach the bearing stage; it does not attain its greatest productivity, however, for another ten or twenty years, and may then continue to give profitable yields for many years. A large increment of production was therefore derived from the areas which had been planted during the previous fifteen years. Thus, although cultivation was neglected, and very little planting took place, the production continued to increase for several years. Consequently, the situation in-so-far as it was affected by conditions within the cacao industry, was aggravated rather than ameliorated.

The severity of the depression was intensified in Trinidad by a number of local features. These included the general tendency for costs of production to rise, the cessation of indentured immigration, the abuse of "claying", the extensive system of mortgages, and the large number of "family estates". Increases in the costs of production on the older properties, which were caused by declines in yields, constituted by far the most serious factor. This is characteristic of "old", but not of "young" cacao producing countries. The consequences of the termination of East Indian immigration in 1917 were temporarily obscured by the high prices of cacao. The indenture system had provided the Trinidad planters with an ample, cheap, industrious and amenable supply of labour. The immigrants were required to live on the estate to which they were indentured for a period of five years. The planter could compel them to work at any agricultural operation for five days a week "out of crop", and six days a week "in crop". The indentured immigrant was entitled to demand work or wages for similar periods but he seldom exercised this right. The planter could assure himself of an abundant and extremely flexible supply of labour, and he could train individuals to perform particular operations without having to offer special inducements. The independent labourers, too, whether East Indian or West Indian, were more amenable when they were in danger of being replaced by newly indentured labourers. In brief, there was great competition for employment.

The indenture system afforded many economic advantages to both planter and immigrant. Unfortunately it encouraged a few inefficient managers to rely upon the legal provisions of the ordinance to regulate their relations with the labourers. These individuals regarded their indentured immigrants as "units of labour" rather than as human beings. There was a more general tendency to regard the minimum

requirements of the Immigration Ordinance regarding housing, sanitation, medical attention, food, &c., as the maximum allowances. Many planters laboured under the fundamental misapprehension that the labourer demanded a definite and unvarying standard of material welfare. They also failed to appreciate the distinction between real and money wages, and assumed that an increase in money wages would automatically result in a corresponding decrease in the output of work.

Most of the foodstuffs consumed in Trinidad are imported, and their prices rose rapidly during and immediately after the War. Money wages lagged behind commodity prices, with the result that real wages declined. With the outbreak of War, the number of indentured immigrants declined owing to difficulties of recruitment and the increasing shortage of shipping. Thus, from 1914-1915 to 1917, the number of East Indian immigrants averaged only 765 per annum as compared with 2,495 during the previous five years (25). The Government of India terminated recruitment in 1917, but some of the immigrants already in Trinidad remained under indenture until 1920. The labourers soon appreciated the change in the situation and demanded higher wages. The planters were making strenuous efforts to expand their output in order to take advantage of the rising prices offered for their produce. The daily wage for men rose to 60 cents (*2s. 6d.*) in 1920, but industrious individuals were able to earn considerably more by task work. Bonuses were also offered to regular workers. These bonus schemes differed in detail but the common principle was the payment of an additional sum to each labourer who worked a certain number of days during the week, fortnight or other predetermined period. In short, within the space of a few years the situation changed from a competition for employment to a competition for labourers.

The fall in the price of cacao in 1921 was seriously felt by the estate owners. Wages were rapidly adjusted, but the lag between expenditure on cultivation and receipt for produce had involved heavy payments at a higher rate of wages. This expenditure had been rendered exceptionally large by the extensive capital improvements which had been stimulated by rising prices. Moreover, although the recruitment of indentured immigrants ceased in 1917, the planting community still remained under an obligation to repatriate numerous East Indians. A cess, which varied according to requirements, was levied for this purpose upon the exports of Sugar, Molasses, Rum, Bitters, Cocoa, Coconuts and Copra*. Since 1920, more than 10,000 East Indians have returned to India, and many others retain the right to an assisted passage (25). This cess further reduced the price received by the planter for his produce.

Table VIII.

NUMBER OF EAST INDIAN IMMIGRANTS ENTERING TRINIDAD UNDER THE INDENTURE SYSTEM (36), (40).

Period	Annual Average.
1845-48*	1,326
1851-59*	1,303
1960-69	2,017
1870-79	2,312
1880-89	2,458
1890-99	2,366
1900-09/10	2,335
1910/11-17	1,628

*No recruitment took place in 1849 and 1850.

N.B.—*The authorities quoted, record different numbers for several years. The writer has selected those figures which appear to be the more authoritative.*

The prices of Trinidad cacao were unduly depressed by abuses of the practice of "claying". Cacao exported from Trinidad may be divided into two principal classes, namely, fermented (usually termed "plantation") and unfermented (usually termed "ordinary" or "shop"). The former is subjected to a process known as fermentation or sweating, which is omitted or imperfectly performed in the latter. A thin coating of red clay was applied to plantation cacao in the form of a "wash" or powder. This gave the cacao a uniform and prepossessing external appearance. Cacao beans prepared during rainy weather have a dark and blemished external appearance which seriously diminishes their price, despite the fact that the nibs may be perfectly sound. Claying enabled the planter to hide the shells, which were of little value to the manufacturer, and to obtain the full price of plantation cacao. It was also contended that claying prevented the formation of moulds during storage, tended to preserve the aroma of the beans, and served to distinguish fermented from unfermented cacao. This practice was confined to Trinidad and Venezuela, and since the neighbouring Republic had an outstanding reputation for quality, claying was regarded as the "hall-mark" of good plantation cacao.

The amount of clay added by most planters varied between one-half and two per cent. of the weight of cacao, and much of this was absorbed by the labourers' feet or the drying floor during "dancing". A number of unscrupulous individuals discovered that clay was cheaper than cacao, and proceeded to use clay in excessive quantities with the profitable object of adding weight. The degree to which this practice was abused may be gauged from the report of the Cocoa Manufacturers' Association of America, that, in 1922, more than 60,000 bags out of a total of 118,000 bags examined, were clayed to the extent of 5 to 20 per cent (5). Clay was also used to give unfermented cacao the same external characteristics as plantation

* No cess has been levied since 1928. Sufficient funds remained in the Planters' Immigration Fund to provide for return ships in 1929 and 1931. It is proposed to meet the expenses of repatriation in 1932 from the General Revenue of the Colony. (*See* Report of Committee on Repatriation of East Indian Immigrants—Council Paper No. 53 of 1929.)

cacao. These abuses were particularly prevalent during 1919 and 1920 when an unusually large quantity of cacao had been sold for future delivery, and spot prices in the meantime had substantially risen. Under such circumstances, it was preferable for the buyer to ignore these deceptions rather than to reject delivery. In 1921 and 1922, when cacao had been bought in advance, and spot prices were considerably lower at the time of delivery, the buyers found it advantageous to make strongly-worded protests, and the matter was speedily brought to a head.

These abuses injured the reputation of Trinidad cacao to such an exent that inferior types of cacao from other countries sometimes realised higher prices (6). Several important manufacturers entirely gave up the use of Trinidad cacao. The manufacturers in the United Kingdom and the United States of America objected principally to the use of clay in a fraudulent manner, either as a means of adding weight or of disguising unfermented as fermented cacao. They claimed that the recognised trade descriptions could not safely be applied to Trinidad cacao. Some affirmed that claying did not prevent the formation of mould, while others doubted whether it assisted to preserve the aroma of the bean (6). A Committee of the Agricultural Society of Trinidad and Tobago was appointed to examine the situation. It reported that administrative measures would not prevent abuses, and therefore recommended that claying should be prohibited (5). This proposal was carried into effect by Ordinance No. 43 of 1922 which rendered claying illegal from 1st January, 1923 (11).

Two other features tended to heighten the incidence of the depression, and to prejudice the future efficiency of the industry in Trinidad. These were, the large number of mortgages, and the increasing number of "family estates". The existence of an extensive system of mortgages has previously been explained. A number of estates had been purchased with the aid of mortgages at fabulously high prices in 1920. Many older mortgages had already been reduced, paid off, or foreclosed, but large numbers still remained. For the first time during the past hundred years, numerous planters were unable to maintain the regular payment of interest without allowing their standard of cultivation to deteriorate.

The situation was complicated by the large number of "family estates" which arose in the following manner. On the death of the original owner, the property, which often was encumbered, passed to his heirs. This division of ownership now extends in some cases to the third generation. Instead of selling the property and distributing the proceeds, the beneficiaries preferred to retain a share in the profits of the estate. They considered that a cacao property was as good as any "gilt-edged" security, and would yield a much higher return. Many appeared to assume that heavy yields, high prices, and large profits would be maintained for an indefinitely long time. They took little or no active part in the detailed management of the estate, and, as long as rising prices compensated declining yields, they received steady and substantial incomes. The fall in prices in 1921, the pressure exerted to maintain the income of the estate at its accustomed level, and the effort to continue the payment of interest on encumbrances, necessitated a drastic reduction of estate expenditure. The neglect of cultivation, which has now been continued over several years on many estates, has resulted in seriously reduced yields.

It may be stated then, that the fall in the prices of cacao in 1921 affected all cacao producers, but the incidence of the depression was accentuated in Trinidad by declines in yields, the termination of indentured immigration, the continued repatriation of East Indians, abuses of claying, the existence of many heavy mortgages, and the increasing number of "family estates".

The cacao planters in general endeavoured to meet the situation by curtailing expenditure, attempting to enhance the reputation of Trinidad cacao, and diversifying their crops. Wages were reduced from about 60 cents (2*s*. 6*d*.), to 40 cents (1*s*. 8*d*.) or 45 cents (1*s*. 10½*d*.) a day for men. This, however, inadequately represents the extent of the reduction. In order to appreciate this question it is necessary to explain the conditions of employment. Labourers are usually engaged daily, and there is no obligation for the employer to provide regular work or for the employee to work regularly. The planters provide barrack-rooms free of charge to encourage labourers to dwell on the estate.* Often small gardens are offered free of rent to the labourers. Few individuals avail themselves of this facility because imported food can usually be bought more cheaply, and praedial larceny is prevalent. Regular labourers are generally allowed firewood, bananas and other fruit, and occasionally a few vegetables, either free of charge, or at a nominal price. Thus, the money wages of many labourers are supplemented by appreciable allowances.

Work is performed by the day, the task, or the job. Labourers employed by the day commence work at about 6.30 or 7.00 a.m., and finish at 5.00 p.m. with an interval of an hour for breakfast†. They work in gangs, of variable size, under the immediate supervision of a "driver"‡. Those engaged in task work ‖ are assigned a definite

* An increasing number of labourers rent or construct dwellings off the estate in preference to living in rent-free barrack rooms.

† Breakfast in Trinidad is equivalent to lunch in England. The early morning meal is termed either "coffee" or "tea".

‡ A "driver" is sometimes more euphemistically termed an "overlooker". He is equivalent to a foreman.

‖ Task work was introduced to ameliorate slavery by affording the more skilled and industrious individuals an opportunity to complete their quota of work early in the day, and to devote their spare time to occupations which enabled them to purchase manumission or comforts.

portion of work, *e.g.*, digging or cleaning a certain length of drain *, cutlassing the weeds over a given area †, or picking a certain quantity of cacao ‡. The task consists of either an amount of work equivalent to that expected from the average labourer in a day, or a round number of easily measured units, *e.g.*, 100 feet of drain, or 100 trees, or a barrel of cocoa. The industrious labourer can finish a task in a few hours, and can augment his wages by completing more than one task in a day. Since the task is "measured", *i.e.*, accepted and credited to the individual, only when it is satisfactorily completed, there is no need for constant supervision. The labourer begins and finishes his work when he pleases. This system of "piece-work" is preferred by both labourers and managers.

Task work cannot be applied satisfactorily to operations entailing great skill, care or patience, or to occupations in which the output cannot be measured with ease and accuracy. Thus, a cacao-picker§ paid by the barrel of wet cacao will be tempted to include over-ripe, unripe, diseased, and damaged cacao, and to ignore the less accessible pods. He may occasion serious damage to the fruiting cushions by the careless use of the cutlass or picker. A stock-man, engaged in feeding the animals, cannot be assessed according to his output, and is paid by the day.

Job-work is similar to task-work, but is conducted on a larger scale. For example, a jobber will undertake to cutlass a whole field, whereas the task comprises merely a hundred trees or some similar unit. Job-work affords the individual an opportunity of earning money with the aid of his family or hired labourers. It is encouraged by some planters as an easy means of obtaining labourers and reducing the costs of supervision. Since the termination of the indenture system task and job-work have been extended in some cases to operations better performed under close supervision, such as picking cacao, and pruning the trees.

The size of the task usually remains constant but the remuneration varies according to the amount of work entailed. Thus, if weed growth is heavy and difficult to remove, or the ground is hard, or the drains very dirty, the payment will be increased. Consequently, the amount paid for a task varies enormously with different fields, times and estates. The planter can vary his rates according to circumstances, but there is no ready means of assessing the extent of the alterations. In 1921, the planters curtailed their expenditure by reducing the rates paid for day, task and job-work.

* The length of the drain is measured by "the rod" (10 feet), or the "planter's chain" (100 feet).

† The area to be cutlassed is determined by the space occupied by a number (usually 100) of trees or pickets.

‡ Wet cacao, *i.e.*, the beans as extracted from the pods, is roughly measured by the barrel, basket, or box. These units vary in capacity.

§ A cacao-picker is usually designated "a rod" by reason of the long bamboo rod employed to reach pods on the upper branches of the trees.

Table IX.

SHOWING RANGE IN THE AMOUNTS PAID FOR VARIOUS TASKS ON TRINIDAD CACAO ESTATES.

Nature and Size of Task.	Rates Paid. Minimum. *cents.*	Rates Paid. Maximum. *cents.*
Cutlassing Weeds, per 100 trees	30	70
Weeding, per 100 trees	80	160
Forking, per 100 trees	150	300
Pruning, per 100 trees	50	250
Digging New Drains, 12 inches by 12 inches, per 100 ft....	24	40
Digging New Drains, 18 inches by 18 inches, per 100 ft....	36	60
Cleaning Drains, per 100 ft.....	5	20
Roundridging, per 100 ft.	5	30
Picking, Gathering and Heaping Cocoa per brl.....	60	150

Expenditure was further diminished by neglecting in various degrees the cultural operations of the estate, such as trimming and pruning, cutlassing and weeding, draining, control of pests and diseases, and supplying blank spaces. Such repairs to buildings as were not absolutely necessary were indefinitely postponed. A small saving was effected by curtailing or eliminating the provision of medical attention, hospital accommodation, sick diet, medical requisites, and sanitation. Proprietors who employed indentured immigrants were compelled to supply these facilities and it was customary to extend them to all labourers whether East Indian or West Indian, indentured or unindentured. With the termination of the indenture system, hospital accomodation was withdrawn from many estates but often medical attention and requisites were still maintained. The urgent need for reducing expenses led to the widespread withdrawal of all medical facilities that involved any cost to the estate. A survey of estate labourers by Seagar (26) during 1928-29 revealed a high percentage of individuals with obvious clinical manifestations of diseases such as hookworm and malaria. This percentage would not have been so high if regular medical attention and proper sanitation had been continued. This reduction in outlay on medical and sanitary provisions was one of the most regrettable consequences of the termination of the indenture system and the fall in produce prices.

In addition to reducing wages, some proprietors curtailed the costs of management and supervision by replacing the full-time resident manager by a part-time "visiting" or "planting attorney".

Tables X, XI and XII, show that the costs of management and supervision per bag of cacao are far higher on the "worst" estates, on those yielding less than five bags of cacao per thousand pickets, and on those less than 250 acres in area, than in any other groups. Thus, in 1923-24 (when substantial reductions had already been effected) the cost of management and supervision

on the "worst estates" amounted to $7.13 per acre. This was reduced to an average of $4 63 for the seven-year period 1923-24 to 1929-30. The salaries paid to resident managers of medium-sized estates (say between 200 acres and 300 acres) average $600 (£125) to $960 (£200) a year. Such an outlay on management alone would prove crippling to a small estate. For many years the proprietors of numerous small estates had engaged the managers of nearby estates to look after their cultivation. This arrangement proved fairly satisfactory, except when the aggregate areas became excessive, or the distances between the properties absorbed a great amount of time in travelling. The utilisation of the motor-car made it possible to extend this system by employing a planter of exceptional ability to supervise estates scattered widely over the island. These "visiting attorneys" receive only a small remuneration from each individual estate but their aggregate salary is more or less commensurate with their recognized ability.

The "planting attorney" visits each estate at intervals of a week, fortnight, or even longer period. This system is satisfactory when the function of the attorney is confined to matters of general policy. On the other hand, when the sole object of the arrangement is to reduce managerial expenses, there is much in it to be condemned. The critical factor is the ability of the actual resident in charge of the estate. Often he is a "driver" of little initiative or skill. His principal function is to "police" the property, and his remuneration is barely commensurate

Table X.

AVERAGE COST OF MANAGEMENT AND SUPERVISION ON THE "BEST ESTATES", "ALL ESTATES" AND "WORST ESTATES" 1923-24 TO 1929-30.

	Per Acre.		Per cent. of Total Expenditure.	Per Bag of Cacao.	
	$ c.	s. d.		$ c.	s. d.
"Best Estates"	4 82	(20 1)	25	2 29	(9 6½)
"All Estates"	4 91	(20 5½)	22	3 11	(12 11½)
"Worst Estates"	4 63	(19 3½)	19	4 57	(19 0½)

Table XI.

AVERAGE COST OF MANAGEMENT AND SUPERVISION ON ESTATES HAVING DIFFERENT YIELDS, 1923-24—1929-30.

Yields in Bags per 1,000.	Cost of Management and Supervision.				
	Per Acre.		Per cent. of Total.	Per Bag of Cacao.	
	$ c.	s. d.		$ c.	s. d.
Less than 3	3 04	(12 8)	13	3 70	(15 5)
3-5	4 40	(18 4)	23	3 91	(16 3½)
5-7	4 75	(19 9½)	23	2 96	(12 4)
7-9	6 58	(27 5)	24	3 02	(12 7)
9-11	5 68	(23 8)	23	2 31	(9 7½)
11 or over	6 81	(28 4½)	18	2 25	(9 4½)

Table XII.

AVERAGE COST OF MANAGEMENT AND SUPERVISION ON ESTATES OF VARIOUS SIZES, 1923-24—1929-30.

Size in Acres.	Per Acre.		Per cent. of Total.	Per Bag of Cacao.	
	$ c.	s. d.		$ c.	s. d.
Less than 150	6 02	(25 1)	23	3 53	(14 8½)
150-250	5 45	(22 8½)	22	3 36	(14 0)
250-350	4 99	(20 9½)	26	2 91	(12 1½)
350-550	4 92	(20 6)	22	2 97	(12 4½)
550-750	3 11	(12 11½)	21	2 72	(11 4)
750 or over....	3 59	(14 11½)	16	2 90	(12 1)

with his attainments. The "visiting attorney" is unable to exercise that detailed control over the day-to-day operations of the estate essential for the maintenance of efficiency. In short, the system in its least efficient form, may be regarded as an expedient briefly to prolong the economic life of the estate.

The planters also endeavoured to restore and enhance the reputation of Trinidad cacao. The abolition of claying has already been mentioned. The manufacturers had also criticized the practice of mixing fermented and unfermented cacao, and the inclusion of broken and inferior beans and other waste material. They recommended that Trinidad cacao should be graded (5), but no immediate action was taken. When it became clear that the mere abolition of claying had not prevented the rise of new abuses, and had not restored prices to their former level, serious consideration had to be given to the matter. By the end of 1925, a scheme had been formulated, recommending that Government officials should inspect and certify the grades of all cacao intended for export (37). The Chamber of Commerce approved of the principle (37), but subsequently objected that its administration would cause undue and intolerable interference in the conduct of business operations (31). In the meantime, there had been a substantial rise in the price of cacao, which suggested that the low prices obtained during the three-year period 1920-21 to 1923-24 were due, not to the particular methods of marketing Trinidad cacao, but, to general factors affecting every cacao producing country. The idea of Government certified grades was abandoned, but a recommendation was made that exporters should voluntarily employ independent inspectors to certify their grades. This proposal was put into effect by the Cocoa Planters' Association alone (28), but, as other exporters declined to follow this lead, the Association discontinued the practice in 1927. Although the general scheme proved abortive, the experience of the Cocoa Planters' Association is of great significance, for it clearly demonstrates that grades can be certified without undue interference with business.

The fall of cacao prices to a barely profitable level, induced many planters for the first time to give serious attention to subsidiary crops. Cacao cultivation had remained so highly remunerative for fifty years that it had been extended to unsuitable soils. The introduction of any subsidiary crop which involved a restriction of the area under cacao would have been regarded as a certain means of reducing the income of an estate. The high price of rubber at the beginning of the twentieth century encouraged planters to hope that an additional profit might be derived from the cacao fields by substituting the rubber tree for the Immortel shade tree*. Official opinion as early as 1887, and for the next twenty years, strongly favoured *Castilloa elastica* (19), (22), and about 3,000 acres were planted in this variety, principally between 1896 and 1910. It was later appreciated that *Hevea brasiliensis* was commercially far superior and two million *Hevea* seeds were imported from Malaya during 1909 and 1910. The passing of the rubber boom of 1910 caused interest to wane before a large area had been planted in *Hevea*. *Castilloa* proved an expensive failure*. *Hevea*, also, was unsatisfactory as a shade tree, but gave good yields of rubber. Most planters cut out the rubber trees, but a few sacrificed their cacao, and, in 1930, 553 acres of rubber remained in Trinidad (8).

Before the War, the United Kingdom purchased a large percentage of its sugar requirements from European countries (27). Imports of sugar from enemy countries ceased at the outbreak of war, and other sugar-beet areas became the scene of military operations. On the other hand, cacao production was rising rapidly, and the enemy markets were being closed by the Allies' blockade. For these reasons, and its greater importance as food, sugar had prior claim to shipping space. Consequently, in Trinidad, the price of sugar rose more rapidly than that of cacao. The owners of low-yielding cacao estates near the sugar belt replaced their cacao by sugar-cane. In these cases sugar-cane became the principal crop. On other estates, a few coconuts were planted. Often the coconuts had slender chances of thriving because they were planted on land which had proved definitely unsuited to the production of cacao. Most estates also bore a few lime, mango, tonca bean, orange, grape-fruit or avocado pear trees, coffee bushes, or banana plants, grown more for household consumption, or as interesting specimens, than for commercial purposes.

The attitude of the planters towards subsidiary crops may be summarised briefly by stating that where cacao was profitable no other crop was allowed to compete for land. This is clearly shown by the figures obtained for 1923-24 (the earliest period for which comprehensive data is available) when the income from all sources other than cacao represented only 10 per cent. of the total. On the "best estates", subsidiary sources of income accounted for merely two per cent. of the total, but on the "worst estates" they constituted as much as 31 per cent.

The slump in cacao prices led planters to make more definite efforts to diversify their sources of income. They shared, with all agriculturists, the difficulty of selecting suitable and more profitable alternative crops. They frequently found it advantageous to continue their cultivation at temporarily unprofitable prices rather than to abandon their fields and suffer heavy capital depreciation. For this reason the supply of agricultural commodities in general is inelastic, and agriculturists are particularly ill-adapted to curtail production during a period of falling

* Other West Indian Islands, Ceylon, Java, and British Honduras also tried rubber as a shade tree for cacao (41).

* Mr. H. C. Pearson, Editor of the *India Rubber World*, described Castilloa as, "The most provoking aborescent weed that ever flourished on earth" (24).

prices. There are special obstacles in the way of producers of long-period crops. Thus, the producer of short-period crops can substitute, within narrow limits, a crop which offers prospects of greater reward for a similar one that is temporarily unprofitable. This does not necessarily involve any loss of capital, which is the case in changing from cacao to other crops. Alternatively, the preparation of new land for additional cultivation necessitates substantial expenditure.

The cacao planters concentrated upon coffee, which involved neither the sacrifice of the cacao trees, nor the preparation of new land. Thousands of coffee bushes were planted along the traces, roads, and field borders, or between the cacao trees, and occasionally as separate cultivation. Coffee had at one time been an important minor crop in Trinidad. In 1838, the exports of coffee reached 451,437 lb., but they declined to an average of less than 30,000 lb. from 1860 to 1870. The exports afterwards fluctuated a great deal, but, during the ten years 1914 to 1923, they averaged only 26,000 lb. (16). Over the same period the annual imports of raw coffee averaged 315,000 lb. (16). By 1924, many bushes had come into bearing. From 1924 to 1930, the average annual exports jumped to 479,000 lb. The imports of raw coffee fell to less than 18,000 lb. during the five years 1924 to 1928 (16). The promising growth of the industry made Government apprehensive of the danger of introducing coffee pests and diseases into the Colony. The Coffee Berry Borer, *Stephanoderes hampei*, was a very serious pest in Brazil at that time, and a similar beetle (which may be the same species) was recorded in Surinam. The importation of raw coffee was prohibited from 1st March, 1928 (15).

Table XIII.

TRINIDAD EXPORTS AND IMPORTS OF RAW COFFEE. (21), (36), (37), (8), (16.)

Annual Averages.

	Exports.	Imports.
	lb.	lb.
1821-29	263,207	?
1830-39	208,849	?
1840-49	219,124	?
1850-59	72,508	?
1860-69	28,693	?
1870-79	27,558	?
1880-89	25,394	?
1890-99	21,902	570,808*
1900-09	31,595	628,830
1910-19	22,799	311,384
1920-29	293,620	122,052
1930	490,688	nil
1931	853,552	nil

*Average of the five years 1895 to 1899 only.

N.B.—*The authorities quoted, record different quantities for several years. The writer has selected those figures which appear to be the more authoritative.*

More attention was also devoted to grape-fruit, limes, coconuts, tonca beans, timber, &c. The low prices obtained for almost all tropical crops, and the uncertain outlook, discouraged most planters from committing themselves too deeply to any single crop. The planters derived no immediate relief from these subsidiary crops as they took several years to come into bearing. Nevertheless much useful information was acquired, and this may prove of considerable utility in the future. The effect of these efforts may be anticipated a few years by stating that, by 1929-30, subsidiary sources of income increased their percentages of the total to averages of 13 on "all estates", four on the "best estates", and 35 on the "worst estates".

The alarming fall in cacao prices during 1920-21 came as a profound surprise to the cacao planters of Trinidad. They were ill-equipped to withstand the effect of a prolonged period of low prices. The widespread and confident belief in 1920 that prices would remain at an exceptionally high level had encouraged them to spend freely and lavishly. Many planters paid off or reduced their mortgages and other encumbrances, but some were encouraged by the promise of greater prosperity to incur new indebtedness for the further development of their estates. Large sums were spent in capital improvements. In general the planters retained only small financial reserves, for the improvement of their estates appeared to them to be a most promising investment. During the next three years (1921-22 to 1923-24) the average prices of plantation cacao remained very low, being, respectively, $10.80 (£2 5*s.* 0*d.*), $9.52 (£1 19*s.* 8*d.*) and $9.50 (£1 19*s.* 7*d.*) per fanega. Although wages, and, in some cases salaries, were reduced, and expenditure on cultivation and buildings was curtailed, the finances of many estates became deeply involved. Pessimism prevailed throughout the industry.

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CITRUS AND BORON.

RECENT investigations have shown that traces of boron are essential for the normal growth of *Citrus*, even though comparatively small additional amounts are toxic. *Citrus* trees make excellent growth when the culture solution contains 0.2 parts per million of boron but show pronounced physiological disturbances when boron is absent. A concentration of boron less than that required for the normal growth of *Citrus* brought about the following symptoms of decline: leaves curled along the midrib with the tip of the leaf curling downward; leaves coloured a brownish or yellowish green, often with a yellowing along the midrib; midrib or veins conspicuous, corky and split; and a progressive loss of affected leaves in the basipetal direction. In severe cases there is a tendency towards "multiple bud" formation due to new twigs dying when barely visible. This and other symptoms are similar to those found in exanthema. When the bark of the internodes of the twigs, or in severe cases that of the trunk, splits, an amber-coloured gum oozes out. Eventually the cracks may widen so that the woody tissue is exposed. In severe cases the apical portion of the branch dies back. The roots become dark brown in colour and fail to elongate, and in advanced cases the rootlets decay. Upon the addition of a suitable concentration of boron to the culture solution, the symptoms of decline disappear.

Boron appears to be essential for cell division in the meristematic tissue of growing points, such as buds, but it is likewise essential for cambial activity. The abnormal accumulation of carbohydrates in the leaves of boron-deficient *Citrus*, coupled with the fact that the phloem tissues are destroyed, show that translocation is seriously interfered with. Reduction in the total sugar content of the leaves accompanies recovery of the tissues brought about by the addition of boron to the culture solution.—(*Hilgardia*, Vol. V, No. 8.)

STUDIES IN TROPICAL LAND TENURE.

By H. M. Leake, sc.d.

Introduction.

The evolution of a system of land tenure results from one of the earliest reactions of man in the process of civilization. It originates in the desire for security. As soon as the migratory phase passes, to be followed by the sedentary phase associated with which is the growth of crops, the need arises for security that whoso sows, the same shall reap. The elements of a system of land tenure exist among all races which have become sedentary. The crystallization of these elements into a well defined code is a matter dependent primarily on the density of the population, itself dependent on the kindliness of the climate, and, secondly, on the extent of the evolution of a settled government. The system of land tenure, whatever form it may take in practice, is the primary human reaction to the need for assuring a food supply. In its most elementary form its object is to assure the supplies required for the support of the cultivator, his family and dependants; at a later stage, where a section of the population has ceased to be directly dependent on the land, it is to secure an excess production to meet the needs of this non-agrarian population. Not infrequently in the course of history the latter call on production is found to be the dominant one.

Until recent times that was the end all and be all of the question, the production of the essential agricultural requirements of a self-contained population. In recent years a fundamental change has come over the situation. The increase of population which the industrial development of the older countries has made possible, has rendered these countries in some cases dependent for the primary essentials of life, food, and in all cases has created a demand for those agricultural products which form the raw materials of their industry. Further, the higher standard of life which that development has created, has resulted in a permanent demand for products formerly held to be luxuries. Facilities for transport which the parallel development of the power unit has provided, has brought the whole world within the orbit of supply, and few areas remain where production for export is not superimposed on production for local consumption. It would not be a matter for wonder if systems developed to meet the earlier conditions should prove to be ill adapted to meet these later developments; and, as a matter of demonstrable fact, they are not. It may be confidently stated that the demand for these agricultural products will not be denied and the problem raised is to adapt the conditions of tenure in such a way that this demand may be met. But this is not the only aspect of the problem. The old days of exploitation are gone for good and a saner view of the rights of the indigenous population prevails. The problem which faces all administrations where agricultural products are raised for export is thus a dual one; the incorporation of the conditions necessary for such production into the existing system of the country. This is pre-eminently the problem of the Colonies, for, great as may be the mineral wealth of many, their primary source of wealth is, and will remain, agricultural. It is a fundamental problem for this further reason. Our Colonies, mainly tropical, have no monopoly of agricultural production; the area and potential wealth of the tropical lands are practically unlimited. Competition is the order of the day and, unless the Colonies prepare themselves for the struggle, theirs will not be the reward. The advancement in general well-being which all desire for the indigenous races, will not materialize, for this is dependent on production for export.

In these circumstances, it seems necessary to define very briefly the essential needs for production for export. They may be summarized as a regulated supply of a standardized product. There is, as has been said, no monopoly, and competition rules in the world's markets. In these, bulk supplies, capable of repetition and of known standard of quality, will always find the best markets, or even, in times of depression, be the only ones to find a market at all. Security of Colonial development, thus can only eventuate from production fulfilling these requirements.

But the basis of agricultural production is the plant which develops only within the limits imposed by its nature as an organism, and it becomes of importance, therefore, to discover these limitations. No full discussion of this aspect is possible here, but its general nature may be briefly indicated by reference to specific crops. Cotton is a crop which is grown in many Colonies. Quality, which determines price, here depends in large measure on uniformity of type which, since cross-fertilization plays a prominent part in the reproductive process, can only be maintained by a highly organized system of seed supply. Here quality is intrinsic to the plant; in the second example quality is extrinsic to the plant. The oil palm is a crop of which the product as picked is highly perishable; an immediate and skilled treatment must be applied if the form in which the product, palm oil, comes on the market is to be standardized and repeatable. Sugar, to take a third instance, passes through a highly complex process involving heavy capital expenditure and detailed technical control before it arrives on the market in standardized form. Further, for this expense to be justified, assured supplies, necessitating the growth of two or more varieties in regulated proportions, must be forthcoming. Of such a nature are the provisions which must be made if the Colonies are to take their place as suppliers of raw materials in the world's markets, a place, it is necessary to emphasize, which is essential for their orderly development.

Fundamental to the solution of this problem is man's relation to the land, the question of land tenure. As was inevitable, as each Colony was taken over, the settlement of the people formed the most pressing duty, and a record of rights in land formed one of the earliest administrative actions. Equally inevitably, that record attempted to define the *status quo*, the rights as recognized by the indigenous population. Land tenure systems tended, therefore, to crystallize round a form evolved to meet the earlier economic conditions, and nowhere has consideration been paid to the primary requirements for export. Nor is this surprising, for the technical knowledge essential to a correct evaluation of these requirements is of very recent date. With the knowledge now accumulated it is possible to attempt a rough measure of the effect of a system of land tenure on agricultural production, and especially, production for export. The first test is that of yield, though this is no final criterion, for yield may be bought at too great a cost. The second test is quality intrinsic to the plant, and the question to be answered is, can purity of crop be attained and maintained? The third test is quality extrinsic to the plant, and here the question is, can the preparatory processes be conducted so as to yield a high-grade and uniform product? The fourth test concerns capital and applies to those cases where heavy capital expenditure is needed for the preparatory processes; here the question is, are the conditions such as to attract capital? The fifth test is protection from disease, and the question is, can remedial measures be effectively applied? These tests are fundamental, for they are based on the properties of the living organism. Superimposed on them are the tests more commonly applied, which may be termed the human tests, which supply the answer to the questions, will the producer receive a reasonable share of the value as a return for his labour, and will he be afforded opportunity to develop his innate capacity?

The following brief studies of land tenure systems in different tropical or semi-tropical countries are presented in the hope that they may help to place the whole subject of land tenure, particularly as it affects the question of production for export, in its true perspective. They commence with India. India presents a system at once very ancient, very diverse and very complex, but one of which the history has been deeply studied. It serves an introductory purpose for the further reason that it is from India that much of the inspiration of Colonial settlement is derived.

India.

(*a*) *Pre-Moghul Period.*

The source of the intense complexity of the land systems of India must be sought in history. India is a country which, in pre-Moghul days, was composed of a vast collection of independent and warring principalities. The dominant need of all these was the means wherewith to carry on aggressive or defensive warfare. The sole source from which those means could be derived was the land, and the land is indelibly marked as an asset of the State, the demands made on which, subject only to the limit of one-third of the produce as imposed by Sacred Law (Dharma), are less an answer to the question, what must be left to secure to the cultivator his just recompense, than to the question, how much can be taken without killing the goose?

(*b*) *The Moghul Period.*

The Moghul period endured from the thirteenth century till the time of the British occupation. It was an evolutionary period, and the difficulty in presenting any brief summary is necessarily great, but it is hoped the following description adequately represents the facts, and those who are interested in the evolutionary aspect of the system may consult the excellent exposition by Moreland (1). With control over a large portion of India concentrated in the hands of the Moghuls, the land system gradually takes shape and, as developed by Akbar, a man of an administrative capacity and tolerance well in advance of his times, becomes the basis of future policy. That system adopted to a large extent the present day policy of incorporating the system of the country and of applying it through indigenous agency. Its central feature was state ownership of the land, and the mark of that ownership was the land revenue. Akbar built up a very complex system of *assessment* for the determination of the revenue, and an equally complex administrative system for its collection.

The basis of this assessment is the determination, once for all, of the fraction of each crop, and even for each system of cultivation (*e.g.*, irrigated or dry), which is due to the State. The amount payable in each case is calculated usually by actual measurement of the area sown and by estimation of the standing crop. The system depends for its workability on the trustworthiness of the staff and is therefore more efficient the nearer the seat of Government. At this period the question of revenue dominates, and that of tenure appears to be of little moment. The cause of this is the paucity of the population; land is everywhere in abundance, and oppression is checked by the fear of migration of the peasantry.

Theoretically, the relationship is a direct one between the ruler and the peasant, but this direct relationship is not universal. In the first place, the Moghul Empire was built up by absorption; the ruling chief became feudatory, and was held responsible for an assessment which he was at liberty to collect very much as he pleased. Secondly, the empire was militant and employed a host of retainers whose recompense took the form of an *assignment*, that is, an area of land the assessment of which agreed with the value fixed for his remuneration. Thirdly, revenue officials were entrusted with the work of collection. Gradually the individual assessment was replaced by group assessment and, particularly during the

later period, the practice of farming out the revenue became common. The system in its purity necessitated a strong central authority, and the evolution towards farming is an indication of decadence. As this decadence proceeded, the host of intermediaries, whether tributaries, assignees or collectors, either asserted their complete independence, or they assumed a position approximating to landholders, paying a fixed revenue. Gradually their divergent origin became lost to view and the three classes merged into one under the common title of *zamindar*. In this way was evolved the triple partnership of State, zamindar (landholder) and tenant, sometimes mistakenly called *ra 'yat* or *ryot*.

(*c*) *The British Period*.

These were the conditions when the British first entered into occupation on the break up of the Moghul Empire. They brought to their first task of settling the country the same conception which they have employed in later times, the conception of adopting the indigenous system. Thus they adopted the Moghul principle of State ownership and of assessment. But they had no clear knowledge of the evolution of the system they found, while they brought with them a clear conception of the landlord system of England. It is hardly surprising, therefore, that the first efforts were to search for a body of claimants for the land, and these they found in the three classes grouped under the single title, zamindar. The *zamindari* system is, in fact, a British institution. It is typical of Northern India over which the Moghul dynasty held the firmest grip. It is now contrasted with the *ryotwari* system prevalent in other parts of India where the peasant holds directly from the State.

The evolution of the British system now follows two courses. Of first importance is the revenue system and the development of the assessment; of secondary, but growing, importance is the determination and codification of tenant rights. The basis of the assessment is a survey demarcating all lands to which there are claimants, and the construction of a record of rights. Land to which there is no valid claimant is demarcated as 'waste land' and passes to the State. Cultivated land is assessed by a field to field survey, involving not only area, but type of soil and crop cultivable. The zamindar is responsible for payment of the assessment, and is at liberty to dispose of his land by lease, sale or bequest.

Interest centres, however, on the argument which raged towards the end of the eighteenth century round the nature of the settlement. This culminated, in 1793, in the Permanent Settlement of Bengal (Regulation I of 1793) which fixed the assessment, for the then administered area, *in perpetuo*. The idea which lay behind this decision was the building up of a body of yeomen farmers; the result was very different, a speculation in land which largely passed into the hands of absentee landlords subsisting on rents. Pressure of population under these conditions forced a consideration of the tenants' position and, by Act VIII of 1885, *occupancy* rights, hereditable and transferable within custom, were conferred on tenants who had held land in a village continuously for 12 years. Under these rights strict limitations were imposed on the power to evict and raise rents. Other forms of tenure recognized were 'non-occupancy' under temporary leases and 'under tenures' where the lease was granted by a tenant and not by a zamindar. With the establishment of the Permanent Settlement, the need for assessment by settlement passes, and future settlements take the form of checking areas and recording rights. An account of this development is to be found in the first Administration Report (1911-12) of Bihar and Orissa.

By the time of the occupation of the districts further west, a reaction had set in; a truer appreciation of the position of the zamindar has arisen, and permanent settlement was discredited. In the Agra Province there are not the large zamindari estates found in Bengal, and there is a temporary settlement fixed at 40 (till recently 30) years. The work of settlement of a district, (which is taken in rotation) is intricate, detailed and expensive, occupying, as it does, a special staff for a number of years. Subject to the payment of the assessment, the zamindar has full power to dispose of his land by sale, lease or bequest.

Here, too, pressure of population raised questions as to the relations between landlord and tenant; and Act X of 1859 was passed to regulate these. This act recognized, among other forms of tenure, *occupancy* tenure, acquired by a tenant after 12 years' continuous occupation, and conferring a permanent heritable right with power to sub-let up to five years, and *non-occupancy* tenure on short leases. The act weighted the scales too heavily in favour of the tenant, and subsequent amendments take the form of attempts to adjust this bargaining power. The main acts are Act II of 1901, and Act III of 1926. The former provided a leasehold tenure of seven years or more which would not count towards the establishment of occupancy rights, while the latter abolished occupancy rights as arising out of continuity of tenure, and substituted *statutory* tenure on leases enduring for life of the tenant and a period of a further five years to his heirs.

At the time of the annexation of Oudh, the pendulum had swung back, and the land passed to large *taluqdars*, but the temporary settlement was retained. The first Oudh Rent Act (Act XIX of 1868) regulated the position of occupancy tenants, but gave no means of acquiring these rights. Act XXII of 1886 went further and recognized occupancy rights as belonging only to those tenants who held land at the time of the annexation; any other cultivator admitted to a holding becomes a lease-holder for seven years during which his rent cannot be raised and enhancements are regulated and only permissible at intervals of seven years. Further, on ejectment, the succeeding tenant's rent was limited to

that previously in force. But pressure of population was having its effect. By 1921 "it had long "been evident that the Oudh Rent Act of 1886 "required revision. It had worked fairly well in "northern Oudh where the population is thin and "there is no pressure on the soil; but it had "completely broken down in southern Oudh, "where there is great competition for land" (United Provinces Administration Report, 1921-22). That revision was effected by the Oudh Rent (Amendment) Act IV of 1921, which entitled a tenant to receive a lease for ten years and renewals for successive periods of ten years, provided he agrees to enhancement which, if not settled by consent, is ordered by a court. These leases, further, gave a five years tenure to the tenant's heirs, thus adumbrating the provisions later adopted for the Agra Province.

It would take too long to follow the developments in other parts of India, as the Punjab, where a zamindari system exists, and the need for defining the relations between zamindar and tenant arose. Over large areas of India, the settlement is ryotwari, and the question of tenancy legislation hardly arises. Other questions take its place such as that of sub-division which, being dictated by religious custom in matters of inheritance, offers a problem of considerable difficulty, since it results in uneconomic holdings. A succinct account of the ryotwari system and the associated problems, has been given by Keatinge (2) for Bombay.

Two points of interest arise from this brief discussion of the Indian land system. The first concerns the determination of land revenue. In Bengal and Bihar and Orissa (and part of the United Provinces) the Permanent Settlement fixed the State's share once for all at a time when local prices ruled. As the world grew smaller, prices hardened till the world price level was attained. This created an incremental value in the land which became the object of speculation, and resulted in a system of small holdings within large estates mainly owned by absentee landlords living on rents. The temporary settlement in other zamindari tracts prevented this development, for, since a portion of the incremental value was appropriated by the State, the opening for speculation was not so great. There is, however, a limit to the incremental value, and it is reached when, as now in India, the world price is reached. The system of settlement has been evolved to its present high level of excellence during this period of generally rising prices, and the wording of the acts which concern both revenue administration and tenancy, carry an implicit assumption that incremental values are the rule. But this is not so, and the question naturally arises whether the system will work as efficiently when the gradual rise is replaced by the fluctuations normal to the world price. Thirty to 40 years is a long time to forecast a reasonable assessment, and it would appear that an assessment for this period must be pitched low or remissions, with all the invidious distinctions connected therewith, will become common. The temporary settlement is essentially a compromise, a balance between cost—the settlement of an area of 36,000 square miles is recorded as costing more than £100,000—and ideal co-partnership between State and zamindar; but it lacks the flexibility enabling it to react to sudden fluctuations of price level. Its efficiency depends on the stability of that price level, and it may be suspected that the agrarian unrest of recent years is in part due to a rigidity incapable of responding to falling prices.

The second point of interest concerns tenancy legislation. Essentially this legislation is an effort on the part of the State to hold evenly balanced the scales between zamindar and tenant. Clearly such legislation can only be temporary, for, in the changing conditions, the relative bargaining capacity is constantly varying. The major force in the past, increase of population, has undoubtedly affected adversely the tenants' position; but this is not necessarily a permanent condition. As Moreland (3) describes it, "the successive amend-"ments may be compared to the work of a "rat-catcher in soft soil; by the time he has "stopped all existing holes the rats have made "fresh ones, and while he is filling these they "break out in another place". Here again tenancy legislation lacks, and necessarily so, the flexibility which would render it an efficient substitute for a true co-partnership between zamindar and tenant.

(d) Systems of Cultivation.

India, considered broadly, is a country of small holdings and of peasant cultivation. Broadly speaking, too, it produces its own agricultural requirements for its exports, exclusive of tea, approximately equal its import of sugar. Its marketing system is developed through the village *banya* and the local *bazaar*. Such products of general cultivation as find an export market are aggregated for the purpose by merchants who deal through the bazaars and the village banya. Examples of organized production for export are not, however, lacking, and these offer points of interest.

The plantation system in all its purity is found in certain parts of India, notably for tea in Assam and Darjeeling, and for coffee and rubber in Southern India. These plantations have been developed in the less densely populated tracts where, on settlement, claimants to ownership were not forthcoming, and large areas of 'waste lands' passed to the State. In Northern India the rapid expansion of tea cultivation led to a demand for land which necessitated the formulation of rules which have been amended from time to time. In Darjeeling, such rules were framed in 1859 when grants were put up to auction at an upset price of Rs. 10 per acre and carried a freehold title. In 1864, farming leases were granted for a term of 30 years, the first five years being rent free and subsequently a rent of as. six per acre per ann. On expiry of the lease, a resettlement is made under conditions limiting the possible increase.

In 1882, the terms were further altered to a primary lease of five years rent free, succeeded by a rent of as. three per ac. increasing annually by as. three to as. 12 after which, subject to certain conditions as to cultivation, the lease was renewable at Re. 1. In 1898, stricter rules came into force. Leases were only granted to *bona-fide* applicants proving sufficient capital for development. The area must be compact and ordinarily not more than 1,500 acres. The lease was transferable but indivisible. The first five years were rent free, during which 15 per cent. of the area must be developed, after which a lease of 30 years was granted which was renewable *in perpetuo* under certain limitations as to increase of rent. This is a typical plantation development of which the main interest lies in the efforts made to check speculation in land while giving the security which will attract capital. Owing to the scarcity of the local population, labour had to be imported, and legislative activity is directed mainly to the control and supervision of this labour force.

Greater interest attaches to that other development of cultivation for export, indigo; for it occurred in the densely populated tract of Bihar, until 1911 a part of Bengal. The indigo industry was introduced into Bihar by Francois Grand in 1782-85 and, by 1793—the time of the Permanent Settlement—nine factories were in existence. It was an exotic industry run, generally, by aliens and superimposed on the standard peasant cultivation of the country. It required control of a certain area to give security for supplies of crop and for the erection of the factory; but the plant required no intensive form of cultivation and was capable of taking its place in the common rotations. It is of interest to note how possession of this land was secured. Partly it was secured by purchase of the zamindari rights as opportunity offered; partly by purchase of ryoti holdings carrying occupancy rights; partly, again, through leases granted as security for loans and through usufructuary mortgages; partly also by leases of villages which included among the terms the growth of a certain percentage of the area under indigo. The indigo concern was thus a complex organization at once zamindar, ryot and under-tenant; its property was widely distributed, a feature which the nature of the plant rendered immaterial. These systems under which land is held are complex, and the relative areas under each vary widely from area to area. The firmest hold on the land is found in North Bihar where, in 1876, permanent leases were granted by the Bettiah Raj in return for a loan of 95 lakhs. (1 lakh= Rs. 1,00,000).

The system of cultivation is nearly as complex as the forms of tenure. Partly the concern undertook direct cultivation on a plantation basis with paid labour, though part payment might take the form of a small holding. The concern also leased out holdings at moderate rates on condition that a certain area of indigo was sown annually, a form of cultivation known as *assamiwar*. It secured part of its crop from leases granted for loans on reduced interest in return for a clause demanding a certain area under indigo and, lastly, there was *kushki* cultivation, where the crop was cultivated by independent ryots and sold to the concern. Again, the proportion of crop grown under these different systems varied widely from locality to locality.

With the development of the artificial indigo industry at the end of last century, the natural industry received a severe check, and early in the present century a demand arose for an alternative crop. That crop was found in sugar, and a factory was erected at Ottur, to be followed by a series of factories of modern type. This development has now secured a firm hold in the tract, and it has done so because of the area held under direct control. It is the only tract where sugar production, in the modern sense involving central factories, has established itself firmly, though the tract extending from Bihar, through the United Provinces to the Punjab grows cane extensively, and the rarity of such factories elsewhere is primarily due to the land tenure system, which prevents control of adequate areas being established and raises almost insuperable difficulties in the way of securing adequate and regularized supplies from an unorganized peasantry. Even in Bihar, adequate facilities were not universally present, and many of the concerns took to general cultivation, a departure which led to considerable unrest over the adjustment of those leases which contained clauses for the cultivation of indigo, unrest used for political agitation and only laid by the passing of the Champaran Agrarian Act (Bihar and Orissa Act I, 1918).

One further development must be noted as peculiar to the United Provinces. As has been indicated, the zamindar developed largely as a rent receiver whom pressure of population placed in too dominant a position, and whose powers were restricted mainly by the establishment of occupancy rights. It was a system which, combined with a recurrent settlement, was not ill adapted to a period of slowly rising prices; but when prices soared, as they did as the result of the war, it proved too inflexible, for rents could not be raised proportionately. The zamindar could not sit by and see the profits of high prices accrue to his tenants, and an urgent demand arose for the establishment of home farms the profits of which would accrue to the zamindar himself. Here the difficulty arose, more particularly in the Agra Province, that compact areas of adequate size were not available, for land held on occupancy tenure blocked the way. The movement was intrinsically sound for, in the home farm based on a canal or tube-well an exceptional opportunity existed for a co-partnership organization which would have done much to raise the standard of cultivation and wealth of the community (*see* Leake (4)). It was a movement, however, which required certain conditions for its success, and these were lacking. It required a zamindar with agricultural experience able to take the initiative;

it required a trained staff of managers (bailiffs) clear as to the aims from the start and, above all, it required time. It is not possible to turn a zamindar brought up to live on his rents into a skilled agriculturist, or to create a band of estate managers in a short time. Probably it would have taken a generation for the movement to gather momentum, and prices collapsed too quickly. But the movement was sufficient to lead to a large expansion in the well boring section of the Department of Agriculture, and to produce legislative action. Thus, the Agra Tenancy Act of 1926 contains a special section defining the conditions under which a zamindar may repossess himself of land for the purpose of farming on improved lines. The movement contains the seed of a true co-partnership which would go far to unify the interests of zamindar and tenant. This no tenancy legislation can do, for it necessarily assumes that these interests are divergent.

References.

1. Moreland, W.H.—The Agrarian System of Moslem India.
2. Keatinge, G.—Rural Economy in the Bombay Deccan.
3. Moreland, W. H.—Revenue Administration in the United Provinces.
4. *Agricultural Journal of India*, XVIII (1923), p. 10, reproduced as App. II in Land Tenure and Agricultural Production in the Tropics.

COLONIAL APPOINTMENTS.

The following appointments and transfers have been made by the Secretary of State for the Colonies :—

Mr. E. S. Garner, Citrus Specialist, Sierra Leone.

Mr. W. N. C. Belgrave (Plant Physiologist), Chief Research Officer, Federated Malay States.

Mr. R. S. Pelly, Assistant Conservator of Forests, British Honduras.

Mr. N. Greenwood (Agricultural Chemist, Nigeria), Chemist, Agricultural Department, Gold Coast.

Mr. H. H. Brassey-Edwards (Chief Veterinary Officer), Deputy Director of Agriculture (Animal Industry), Kenya.

Mr. A. J. Findlay (Deputy Director of Agriculture, Nigeria), Director of Agriculture, Zanzibar.

Mr. G. E. Bodkin (Government Entomologist, Palestine), Director of Agriculture, Mauritius.

Mr. A. S. Thomas (Economic Botanist, Gold Coast), Assistant Botanist, Agricultural Department, Uganda.

Mr. W. E. Bassett (Late Assistant Superintendent, Victoria Botanic Gardens, Nigeria), Assistant Agricultural Officer, Dominica.

Mr. T. R. Hayes (Superintendent of Agriculture, Gambia), Agricultural Officer, Uganda.

Mr. E. Ballard (Late Government Entomologist, Nyasaland), Government Entomologist, Palestine.

BOVINE TUBERCULOSIS AND THE PASTEURISATION OF MILK.

The Ministry of Health has issued a memorandum on bovine tuberculosis in man with special reference to infection by milk (*Reps. on Pub. Health and Med. Subjects*, No. 63, London : *H. M. Stationery Office*, 6*d*. net). A large proportion of tuberculous disease in children less than fifteen years of age is caused by the bovine type of the tubercle bacillus, and it is estimated that more than 1,000 children less than fifteen years of age die annually in England and Wales from infection of this origin, which is derived mainly from cow's milk. The proportion of milch cows in Great Britain infected with tuberculosis is probably not less than 40 per cent., of which probably between one and two per cent. yield tuberculous milk. But as market milk is usually the mixed milk of several cows, the proportion of samples of milk containing tubercle bacilli varies in different areas from about five per cent. to 12.5 per cent. Although much may be done by administrative and other measures to diminish bovine tuberculous disease, complete eradication by tuberculin testing and slaughter of reacting animals, the building up of tuberculosis-free herds, and preventive vaccination, is impracticable. Much may be done by the routine clinical examination of cattle, the testing of milk by microscopic and biological methods, and the keeping of the milch cows under hygienic conditions. The campaign in favour of clean raw milk, as by the use of certified and Grade A milks, while of great potential value, has hitherto met with limited success, probably due largely to the increased cost of such milks. So long as this remains the case, the pasteurisation of milk by retaining it at a temperature of 145°C. for 30 minutes constitutes the best safeguard against bovine tuberculosis derived from milk. The opinion is expressed that pasteurisation carried out in a suitable apparatus and under strict scientific control is capable of protecting the consumer from the danger of infection with the tubercle bacillus, and that milk so treated appears to retain its valuable food properties practically unimpaired.—(*Nature*, Vol. CXXVIII, No. 3218.)

AN APPRECIATION.

Dwarf Coconuts.

Mr. A. P. Skeat, Londonderry, St. Lucia, has presented the College Department of Agriculture with planting material of three varieties of the Malayan Dwarf coconuts. In 1930, Mr. Skeat sent 12 nuts of each of the yellow and green varieties, and in June, 1932, he sent 12 sprouted nuts of the red variety. The gift of these nuts is acknowledged with appreciation of Mr. Skeat's generous action.

STUDENT INVESTIGATIONS.

The following is a list of some of the papers prepared by students while in residence at the College. These are available in the College Library for reference.

1930-1931.

I. W. M. Armstrong-Black, B.Sc., Ph.D. (St. Andrews)	An investigation of fraction methods for studying plant residues and organic matter in soils.
W. J. Badcock, N.D.A., Dip. Agric. (Reading)	An ecological study on sugar-cane soils.
J. A. Baker, B.Sc., A.R.C.S. (London)	High priming of tobacco.
J. E. P. Booth, B.Sc., Agric. (London)	1. Survey of the cacao industry in Trinidad. The Talparo District. 2. Management as a factor in the production of cacao in Trinidad.
D. H. Brown	Yam cultivation, with particular reference to the results of field trials conducted at the Imperial College of Tropical Agriculture, 1930-31.
J. N. Clothier, Dip. Agric. (Wye)	Cacao industry in Trinidad.
W. T. Dalgarno, M.A., B.Sc. (Aberdeen)....	Sweet potato growing in Trinidad.
R. E. T. Hobbs, Dip. Agric. (Reading)	Digestibility trials of savannah grass and coconut meal.
J. D. Jameson, B.A. (Oxon.)	The spacing of maize.
J. G. M. King, Dip. Agric. (Wye)	The diversification of cacao.
L. N. H. Larter, B.Sc., A.R.C.S. (London), and T. A. Russell, B.Sc., A.R.C.S. (London), Dip. Agric. (Cantab.)	1. Leaf-stripe in maize. 2. Curly leaf of the papaw.
G. W. Lock, N.D.A., N.D.D., C.D.A. (Midland Agric. College), (1929-1930)	A study of the influence of intensity of cultivation of the final results of cacao growing in Trinidad.
W. J. Mill Irving, B.Sc. (Edinburgh)	Maize variety and spacing trial. A vindication of Imperial College of Tropical Agriculture farm practice.
A. F. Nichols, (1928-1931)	A study of some of the constituents of the juice and the maturing of the cane under different environmental conditions.
G. D. P. Olds, B.Sc. Agric. (Reading)	The effects of ploughing in Bengal Beans at different intervals on the succeeding crop of maize—and subsidiary notes on the effects of Bengal Beans as a green manurial dressing for cotton.
E. Parry-Jones, B.Sc. (Wales), F.E.S.	The biological control of *Clidemia Hirta* D. Don.
E. O. Pearson, B.A. (Cantab.), (1929-1930)	The cotton stainers of Trinidad, B.W.I.
M. F. Rose, B.A. Hons. (Cantab.)	An ecological study of sugar-cane, with special reference to moisture content and nitrate fluctuations in the soil during part of the growing and fallow period.
F. A. Squire, B.Sc. (S. Africa), F.E.S.	Biological control of *Clidemia Hirta D.* Don, Order *Melastomaceae*.
H. B. Stent, M.Sc., A.I.C. (Manchester)	Electrodialysis and its application to soil nutrient studies.
J. F. Williams	The precipitation of calcium carbonate with special reference to sugar manufacture.

REVIEWS.

Principles of Soil Microbiology.

By Selman A. Waksman, London, *Baillière, Tindall & Cox*. Second Edition, 1931.—Price 52*s*. 6*d*.

The first edition of this important book, which appeared in 1927, was reviewed in this Journal in March, 1928, where it was described as "indispensible to those scientifically trained as agriculturists, biochemists, soil chemists and biologists". The fact that a new edition, containing numerous additions and revisions, has been called for within the short space of four years amply justifies this dictum. The main emphasis of the book is laid on the interdependence between the activities of micro-organisms and the chemical transformations in the soil. The first two parts of the book deal with the soil population and its isolation and identification. The third part describes the chemical activities of soil micro-organisms, and the last part considers the bearing of soil micro-biological processes on soil fertility. There are thirty-four chapters in all, covering nearly nine hundred pages, and there is an exhaustive list of references to the literature of the subject. Micro-organisms inhabiting the soil and causing certain plant and animal diseases, soil inoculation and the history of soil micro-biology, are discussed in separate chapters. Without doubt, this book is destined to become a classic, and no soil investigator can afford to be without a copy in his library.

F.H.

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An Introduction to the Literature of Vertebrate Zoology.

Compiled and edited by Casey A. Wood. McGill University Publications, Series XI (Zoolcgy), No. 24, pp. 643.—*Oxford University Press*, 1931.

The volume before us is the outcome of nearly six years work on the bibliography of the Vertebrata, based upon the collections in the libraries of McGill University.

The first of the three sections into which the book is divided presents a historical review of the important literature from the earliest times to the present. While the serious vertebrate zoologist would do well to familiarise himself with much of the contents of this section, it is also well adapted for reference, for which purpose it will be found most useful. The chapter headings are well selected and by their aid it is quickly possible to identify the section dealing with the topic of the period required.

Section B is a guide to the literature in the McGill libraries, arranged on a regional basis and subdivided according to classes. A list of authors' names follows, accompanied by short titles of the several works and in this way it is possible to trace rapidly the literature dealing with the desired aspect of study.

The volume concludes with the largest section of all, comprising an annotated list of the books in the libraries, arranged alphabetically under the authors' names. Such highly specialised branches of vertebrate zoology as veterinary science, genetics and so on, are passed over with slight reference owing to lack of space and, indeed, such subjects are probably best treated in separate compilations of the type of the present one.

It is not claimed that the work is complete even within the limits indicated by the title, but the book forms a most valuable aid to the study of vertebrate literature.

A. P.

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The South African Sugar Year Book for 1932.

The 1932 South African Sugar Year Book and Directory (the third annual), will be of particular interest to everyone who has any concern in sugar production or the technical branches of the industry. The new issue has been reconstructed, and a number of new features introduced; it should be invaluable as a reference book and guide. It contains a record of the sugar industry during the previous twelve months, and ranging back to its pioneering days.

Among the special features are the full text of the Board of Trade and Industries Report (No. 119); the Chadbourne Plan; principal events of the year; monthly and annual summary of laboratory reports; rainfall records; sugar production and prices; cane values, and the latest malaria regulations. The table of road distances has been reconstructed and simplified. There is also a complete revised record of motor car registration marks. The sugar chronology has been brought up to-date and enlarged. A record is given of all the principal sugar milling companies, outlining their history and progress.

The price is 5*s*. per copy, including postage, and copies may be ordered direct through the office of the publishers, The S.A. Sugar Journal, Ltd., St. Andrew's Building (Box 1209), Durban, South Africa.

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The Agricultural Situation in 1930-31.

International Institute of Agriculture, Rome. *Treves, Treccani Tumminelli*, S. A., 32, Via Michelangelo Caetani, Rome (115), Italy. Price 25 liras.

This volume follows closely on the one which was published last year, its chief object being to serve as a commentary on the International Yearbook of Agricultural Statistics for 1930-31. The six chapters that it contains deal respectively with the development of the agricultural crisis, market conditions, international action in connection with agriculture, government farm relief measures, the action taken by voluntary organisation in the interests of producers, and the economic conditions of agriculture in all the important countries of the world.

G. G.

PROBLEMS OF THE IRAQ CULTIVATOR.

By D. D. Paterson, B.Sc.

The writer spent some six years in the service of the Iraq Agricultural Department from 1924-1930. As a result of a paper read to the Trinidad Science Club in April, 1932, it has been suggested that a brief description of Iraq from the agricultural aspect might be of general interest to readers of *Tropical Agriculture*.*

The crops grown, the farming systems followed, and the problems of the cultivator offer a striking contrast to those prevailing under such an insular tropical climate as that of the West Indies. To one who has come straight from the semi-desert conditions of Iraq to the luxuriant tropical vegetation of Trinidad, the differences are accentuated, and at first, all in favour of the latter. Later on, however, the overwhelming luxuriance of the greenery of the Caribbean begins to pall, and leaves an impression almost of imprisonment, and, in retrospect anyway, the wide open spaces of the more barren country take on some of the glamour of the desert.

The last part of the journey from England to Iraq across the Syrian Desert gives the traveller an excellent introduction to the "Land of the Two Rivers". From Beyrouth in Syria, the road winds up and over the Lebanon and Anti-Lebanon Mountains to Damascus. This road is a wonderful engineering feat, and for general scenic effect, uncouth gradients and dangerous hairpins, it is at least equal to many of the Alpine Passes. From Damascus, the road (if such it can be called) leads eastward to the Syrian Desert, a barren featureless inhospitable waste, stretching for some 500 miles. Civilization of the eastern type is reached once again at Ramadi on the River Euphrates, where the small groves of Date Palms offer a pleasant relief after the unending brown sameness of the desert.

Topography and Climate.

The greater portion of Iraq is an immense flat plain, in reality, the delta of the Tigris and Euphrates Rivers. The soil is alluvial in character, and stoneless. In general, under proper treatment, it is rich and fertile. The rivers are for the most part confined between high banks or bunds, and the water level is often above that of the plain, which is consequently liable to be flooded when the rivers are in full spate. It is not the rivers which appreciably affect the amount of water, but the melting of the snows in the spring in the mountains of Armenia and Kurdistan. The difference in level of the Tigris at Baghdad between spring and summer may be as much as 25 feet. The average annual rainfall in the Baghdad area is only six to seven inches, falling in the winter months from October to March. The summer months are always quite dry, so that the cultivator has to depend on irrigation water from the rivers to augment the rainfall in the winter, and to supply the whole of the moisture requirements of his crops in the summer. North and north-east of the plains lie the uplands, which merge gradually into the highlands or mountains of Kurdistan. The rainfall in this area is rather more than that of the plains, amounting to some 14 inches, and restricted to the winter season. It is possible, however, in this part of the country to grow *daim* or rain-watered crops in the cold season under a semi-dry farming system of management.

The climate of Iraq as a whole is essentially continental in type, showing large variations between day and night temperatures, and between winter and summer. At Baghdad, the average maximum shade temperature in July and August is about 110°F., but it may rise to over 125°F., while a temperature of 120°F. is not uncommon. The corresponding temperature in the winter months lies between 60-65°F. Compared with these figures, the average maximum night temperature is about 30° lower in the summer, and 20° in the winter. In the summer of 1929, a change of no less than 60°F. within 24 hours was recorded, the mid-day shade temperature being 121°F., and the following night, the minimum being 61°F. The humidity percentage is very low, especially in the summer months, and the atmosphere exceedingly dry. Were this not so, the heat of the summer would be literally unbearable, whereas, with the low humidity, even the hottest days are bearable. The winter months, on the other hand, are extremely pleasant, except on the few occasions when rain falls; each heavy shower turns the whole country into a sort of morass for a day or two, and renders the roads, which are of the baked-mud type, impassable to wheeled traffic.

Population.

The greater part of the population is of Arab extraction, but, in addition, there is a fair proportion of other races, *e.g.*, Kurds, Turks, Jews, Persians and Syrians. The result is that the crowd one jostles against in the *suq* or markets of Baghdad is very cosmopolitan in character, and one can hear there in the course of a few hours, practically every known tongue, many of them unknown to the Westerner. The population for the size of the country is scant, amounting (if the census figures are any indication) to about three millions.

The agricultural population may be divided into two quite distinct classes, the pastoral and the cultivator class. The pastoral section is made up of Nomads or Beduin tribes, where tribal customs and laws still hold good, and the habits of the people have changed very little

* It should be clearly understood that all opinions expressed are purely personal, and must not in any way be taken to represent the official views of the Iraq Agricultural Department.

from the days of Abraham. Large flocks of sheep, goats and camels are kept and driven from one grazing ground to another, so that large stretches of country are covered during the year. Even at the best season of the year after good rains, the vegetation of the semi-desert pastures, though nutritious enough, is scant, and necessitates the constant removal to new areas. In summer, vegetation practically disappears in the central plains, and the tendency of the Nomads is to move north to the mountain areas where the rainfall is heavier and the vegetation more luxuriant, or to the vicinity of the riverain tracts where cereal stubbles and remnants of summer cultivation help to tide over the dry season. There are many different breeds and types of sheep, none of which are pure, and supplying only a poor quality type of fleece with an undue proportion of undesirable coarse hair.

The cultivator class is limited to the riverain tracts, and to the vicinity of various large irrigation canals constructed by the Irrigation Department. If we except a few of the more enlightened cultivators, the garden areas in the vicinity of the large towns, and the date groves of Basrah, the type of agriculture practised by the ordinary Iraq cultivator is both primitive and extensive. The population is thin, land is plentiful, and the limiting factor is not so much land as water. Even if the policy is a short-sighted one, it is easier and more profitable for the peasant cultivator to move on to a new area when his soil is impoverished, rather than to apply a more and temporarily less profitable intensive system of farming to his existing cultivated lands.

As a race, the Arabs as represented by the shepherd and the cultivator, are both interesting and likeable. They are generally uneducated and illiterate, yet they all seem to have a natural breeding, which one rarely meets among the more primitive farming communities. Arab hospitality is proverbial; it is not a fantasy of the "sheikh" type of novel, but is a reality which has got to be experienced to be really appreciated. Like all primitive people, the Arab is quick tempered, especially in regard to anything that he deems in the nature of an insult; action follows immediately, often with dire consequences. On the other hand, he is almost childlike in the quickness with which his rage can return to happy good humour under skilful guidance. Finally, he has that essential virtue, a real sense of humour, and the ability to appreciate to the full a good joke.

Irrigation.

The low annual rainfall makes irrigation an essential of all cultivation over practically the whole of the rich alluvial plain which forms the main portion of the country. The source of the irrigation water, of course, is the Tigris and Euphrates Rivers, which traverse the whole length of the country, from the mountains of Kurdistan in the north, to the Persian Gulf in the extreme south. The high level of the water in the rivers makes it possible to apply water to the land either by flow or by lift irrigation, the system selected for any particular area depending on the locality and on the contours of the land to be watered. In the first system, large high-level canals carry the water by gravitation for many miles, supplying extensive and fertile tracts by their tributaries and distributaries which take off at suitable points and deliver water to the ultimate irrigation units in the field. The best example of this system is to be found in the middle Euphrates, where a barrage built at Hindiyah has ensured a continuous water supply, even in the summer months, for some six large canals. Such canals may extend for nearly fifty miles. Very careful control by the Irrigation Department of the distribution of water to the distributaries is necessary in order to avoid waste in the upper reaches, and to make certain that the cultivator at the tail gets his fair share. On the lift system, water is hoisted out of the river by some mechanical means, and tipped into an irrigation canal which commands high level land where flow irrigation would be impossible except perhaps in the spring floods. There is a considerable variation in the means adopted to lift the water. First of all, there is the primitive *dalia*, similar to the Egyptian *shadoof*, in which man power alone is used. Briefly, this consists of a horizontal pole supported in the centre at about six feet from the ground by an upright which acts as a fulcrum. At the one end of the pole, a bucket of camelskin is tied by a length of rope, while at the other end, depends a weight, usually in the form of a lump of clay. This weight should be just sufficiently heavy to raise the bucket when full of water. The man operates it by pulling down on the rope when the bucket is empty, until it is forced under water. Then the balance weight comes into action, and raises the full bucket to the level of the canal where the water is emptied, and the whole process repeated. The second method is the *kered*, in which animal power is used, and a large camelskin bucket is raised by oxen yoked to a rope working over a primitive pulley. Usually there is a specially prepared slope or ramp so that the oxen are pulling downhill when the full skin is being raised, and walking uphill when the empty skin is being lowered again to the river. The skin bag is so made that the emptying of the water into the irrigation channel is performed automatically through a neck or tail which only comes into action at the proper moment. Then there is the well known Persian Wheel, and lastly, the more modern pumping plant, consisting generally of a crude-oil engine and centrifugal pump. On account of their greater efficiency and comparatively low running costs, the modern units are gradually replacing the older methods. It was demonstrated at the Government Experimental Farm that the most economical size of plant to use was one with an engine of about 50 B.H.P. and a discharge at the pumping

station on a 20-foot lift of some 8 cusecs. The cost of running such a pumping plant, inclusive of overhead charges and depreciation, would be about 2s. 6d. per hour. Under Iraq conditions, this means that the cost of water for irrigation per acre on such a lift system is approximately 1s. 6d. Relative to the flow system, the output of even the largest type of pumping plant is small, and channel losses by evaporation, seepage, &c., limit the use of the lift system to lands within some two miles of the river, *i.e.*, to riverain areas.

Alkali Lands.

Probably the most important problem that the irrigation farmer in the hot semi-arid regions of the world has to face is the question of salt accumulation in the upper layers of the soil, and the ultimate formation of alkali lands in which the concentration of salts is so great as to inhibit plant growth. That this problem in Iraq is an acute one is self-evident, as quite frequently in the vicinity of the cultivated tracts one encounters large patches of uncultivated soil over which a white incrustation appears in the summer, looking in the distance like a fine covering of snow. This incrustation is composed of chlorides and sulphates of sodium, calcium, and magnesium: sodium carbonate or "black alkali" is not found in Iraq. This salt concentration is due to a variety of causes. First of all, in arid regions generally, the amount of leaching occurring is insufficient to carry away the salts formed in the soil as a result of the natural weathering agencies. This will not normally in itself produce alkali lands, but as soon as such areas come under summer cultivation, necessitating a liberal supply of irrigation water, rapid evaporation occurs at the surface, upward capillary currents of soil water are established, and salts in solution usually distributed over the lower soil strata and in the sub-soil water are deposited in the top six inches. Furthermore, the irrigation water itself contains an appreciable quantity of salt in solution, and this is added to the salts already present. It has been calculated that, on land from which both a summer and a winter crop is grown, some 8,000 lb. per acre of salt is added each year by irrigation water alone, and only a portion of this will be utilised by the crop as plant food. Under such conditions, unless proper precautions are taken, it is only a matter of a comparatively small number of years before good agricultural land is rendered unfit for cultivation.

The proportion of salt lands in Iraq is still comparatively low, so that the problem to-day is one of prevention rather than cure. The matter is urgent however, as it is always the most fertile and accessible tracts that are first cultivated and these would be ruined unless preventative measures are speedily adopted. This is fully realised by the Iraq Government authorities, but the paucity of funds for organizing large-scale measures, and the general incompetence of the average cultivator, together with his neglect of the simpler, though less permanent, methods of prevention, have so far hindered progress. The best and probably the only completely efficient remedy is to apply some system of drainage, whereby the salts are leached by percolation to the drains, and ultimately carried off in the main drainage of the country. Unfortunately, the peculiar nature of the rivers in Iraq renders them largely useless as drainage channels, so that a main drainage system would have to be constructed as a Government undertaking. Alternatively, the drainage water can be run into existing depressions or hollows, or pumped back into the river, neither of which procedures are entirely satisfactory. In some areas (as, for example, along parts of the Dialah River) where the contours of the land make drainage to the river practicable, land has been under cultivation for hundreds of years and yet remains salt-free. The extreme saltiness of the water in the Dialah River in the summer as compared with the Tigris, proves conclusively that it effectively acts as a drainage channel; so much so, that pump-irrigated lands on its lower reaches have been much quicker in salting up than neighbouring tracts irrigated with water from the Tigris. The more temporary preventative methods are, in brief, those adopted by the dry-land farmer to cut down his surface evaporation to a minimum; for example, by the use of a shade crop, by the production of a surface mulch to break the capillary connection with the sub-soil, by the growing of salt-resistant species, by the use of the minimum quantity of irrigation water, and by its application in furrows rather than by completely flooding the land. Such measures are reasonably effective if practised from the start, but they cannot be considered as permanently efficacious. They materially prolong the period during which any given area will remain salt-free and fertile.

Crops.

As a result of the climatic conditions, there are two very distinct agricultural seasons in Iraq—winter and summer. The staple crops of the cold period are wheat and barley, while in the hot weather, the shorter term tropical or sub-tropical species (such as maize, sorghum, rice and cotton) are grown. There are few commercial plants that can thrive successfully through the heat of summer and then survive the winter frosts, so that the longer season tropical crops, such as bananas and sugar-cane, are unsuitable; they can be grown, but they never mature properly and yield badly. On the other hand, certain perennial orchard trees do well, for example, apricots, oranges and dates, in fact the date is generally admitted to be the most important crop of the country, both for local consumption and also for exportation.

The standard of cultivation of the winter cereals on the average is very low. The soil is given a preliminary shallow ploughing with a primitive plough which merely stirs the soil to

a depth of a few inches. Seed is then broadcast and generally covered over by cross ploughing. Until comparatively recently, the only seed available was very mixed in character, of poor quality, and gave low yields. The Department of Agriculture has now distributed many tons of selected good quality high-yielding grain, which has been greatly appreciated by the more progressive cultivators. Subsequent cultural treatment is limited to the application of irrigation water, 5 to 6 irrigations in normal years being required to grow and ripen the crops successfully. Harvesting is carried out largely by hand. The small hand-sickle is used to cut the crop, which is then collected into heaps and threshed out by the treading of animals. The seed is finally separated from the chaff and bits of broken straw by tossing it up into the air where the wind blows away the lighter waste materials. This is the simplest and oldest form of winnowing, and is wonderfully effective if carried out by an experienced worker. Yields are poor, and do not normally exceed an average of 600-700 lb. of wheat per acre. This is in no way indicative of the full fertility value of the soil since, with better seed and more careful cultivation, much of the agricultural land can easily be made to produce 1,200 to 1,500 lb per acre.

While a short staple Asiatic type of cotton has been grown in Iraq for many years, it is only during the post-war period that an attempt has been made to grow a crop more suited to the export market. Since 1918, it has been demonstrated again and again by fairly comprehensive experiments that the most successful types of cotton for Iraq conditions of soil and climate are the "Webber" strains of long staple American Upland, and it is this type, or selections from it, that is universally used for cotton grown for export. The seed is sown on ridges by hand, in the second half of March, some nine inches high and two and a half to three feet apart. Some six to ten seeds are put in each hole, the holes being approximately 15 inches apart on the ridge, on a level with the water line as determined by the initial irrigation. Thinning is done when the plants are about nine inches tall, and two plants only are left in each hill. Inter-cultivation is essential to insure good yields, and horse hoeing of the furrows and hand hoeing of the ridges are carried out sufficiently often to keep down the weeds and aerate the soil. Picking normally commences towards the end of July and continues at intervals till October or November. Sixteen to seventeen irrigations are required by the crop. When the plants are young and the days still comparatively cool, about twenty days can be left between irrigations, but in mid-summer in July and August, this interval must be reduced to eight or ten days. Under careful cultural treatment, yields of over 1,000 lb. seed cotton per acre may be obtained. Unfortunately, the ordinary *fellah* is rather more interested in his summer food crops of maize, rice or sorghum, and the cotton crop suffers as a result; thinning is omitted, cultivation neglected, overwatering indulged in when water is plentiful, and underwatering when it is scarce. In consequence, yields as low as 150 lb. per acre are not unusual, and the average for the country cannot be much in excess of 300 to 400 lb. In spite of this, considerable progress has been achieved, as proved by the almost steady increase in output from 60 bales* of lint in 1920 to 5,200 bales in 1928. While this latter figure is insignificant when compared with the world's total annual requirements, it illustrates the great potentialities of Iraq as a cotton-producing country.

Iraq is especially favoured by climatic and general agricultural factors for the production of dates, as the Date Palm thrives only in dry rainless areas of intense heat, chiefly because rain prevents proper fertilization of the flowers and setting of the fruit. The moisture requirements of the Date Palm are high, so that a good supply of irrigation water is necessary. These two essentials—a long hot dry spell and plentiful irrigation water—are both found in Iraq. In consequence, it is one of the chief date-producing areas of the world. The date groves are limited to the southern half of the country, as the winters are too severe for profitable date growing in the north. The most important centres of the industry are Basrah and Baghdad, but small date groves are found in the vicinity of nearly all the southern towns and villages. The Basrah date gardens are particularly interesting in that irrigation water is provided by the action of the tides in the Persian Gulf, which bank up the fresh water in the river and force it into the creeks and irrigation channels which form a network throughout the date growing area. Sometimes during the high spring tides, salt water actually reaches the date gardens, but the tree is hardy, and, when once established, it is salt resistant, so that little damage results. The importance of the date crop to the local inhabitants can be gauged from the variety of ways in which it is used. There are not many fruits which can compete for flavour and feeding value with a fresh-plucked nicely ripened date of a good variety, and the fruit from the best trees in any orchard rarely reaches the market, but is kept and eaten by the land owner and his family. The fresh fruit is only available during certain months of the year, but the dry date forms one of the staple foods of the Arab *fellah* all the year round. A completely satisfying and very nourishing meal can be made from dates, and the unleavened bread or *khubz* baked by the Arab housewife from home-grown wheat. From the fruit a sweet type of syrup or *dibbis* can also be made, and, by distillation a very potent and fiery spirit known as *araq*. This spirit is generally much overproof, and, while the hardy cultivator can often consume

* The Iraq bale weighs 400 lb.

fair quantities with comparative impunity, the newcomer is wise to exercise caution. From the trunk of the palm, building materials are obtained; from the leaf-stalks, fibre for rope; from the date-stones, charcoal or livestock fodder, and from the sales of the export crop, money to buy the limited luxuries that appeal to the simple tastes of the Arab cultivator. It is not surprising therefore that the Date Palm forms such an integral part of the national life.

Pests.

One of the most serious problems that the agricultural community has to deal with is the locust menace. Only those who have seen a locust swarm at work, or have witnessed the after effects of an attack, can visualise what a scourge this insect can be. One large swarm in the course of a few hours can clear a field of young growing cereals in a way that would do credit to the best modern reaping machinery. There are many different species of locust, but the one that is most troublesome in Iraq is the Moroccan locust or *Dociostaurus Moroccanus*, and this pest appears to a greater or less extent annually in the north and north-east of the country, and takes its toll of crops and pastures. An annual locust-extermination campaign is organized and run by officers of the Agricultural Department. As a result of a good deal of research from 1923-1926, it was found that the most efficient and economical means of combating the locust is by the use of poison baits or of poison sprays. Needless to say, where hundreds of square miles of country—much of which is desert—are involved, the amount of poison required is colossal, and the organization of the campaign no mean task: yet operations were so successful that, by 1930, it could truthfully be stated that the locusts were, certainly not exterminated, but definitely under control, and their damage limited to a mere fraction of that of previous years. Control measures all have to be completed during the nymph stage, before the insect takes to the wing. There still remains the problem of the flying locust which, even when operations in Iraq were perfectly successful, invaded the country in large swarms from over the frontiers, from Turkey, Persia or Syria. While these invaders arrive too late to do much damage to the winter cereals, which are mostly harvested before they appear, they lay the seed which will produce the succeeding year's batch and necessitate a repetition of large scale anti-locust operations. It is this possibility of external invasion by the flying locust which makes the locust menace an international problem, and has led to the establishment of the International Locust Bureau whose aim is to arrange for reasonable co-operation between the countries affected.

Agricultural Research.

Research is carried out on the Government Farm, situated on the banks of the Dialah River, some ten miles south of Baghdad. The farm is about 1,000 acres in extent, one-fifth of which is laid out in permanent experimental and research plots, while the remaining four-fifths are farmed on semi-commercial lines, and serve for the quick propagation of selected varieties of seed for ultimate distribution. It is the only agricultural experimental station in the country, and, like all similar institutions, it is supposed to be able to fulfil the functions of a complete encyclopaedia on all matters agricultural pertaining to Iraq. The result is that the activities are numerous and diverse: they can roughly be divided into two main groups. In the first group are included the major activities, comprising fairly comprehensive research on the main crops of the country, namely, the winter cereals (wheat and barley), and the summer money crop, cotton. The work consists primarily in attempts to produce, by breeding and selection, improved varieties suited to Iraq conditions, and, secondly, of experiments in field technique to supply much-needed information to the practical farmer on such points as times of sowing, water requirements, cultural treatment, &c. By 1928, four high yielding, good quality strains of wheat, two of barley, and three of cotton had been selected, thoroughly tested, propagated and distributed to the more progressive cultivators.

The second group comprises the almost innumerable minor research activities which aim at obtaining fundamental knowledge on subjects of more limited agricultural significance. In this section is included research work on livestock improvement, oilseed and fibre crops, sericulture, implements and machinery, salt accumulation and eradication, and farm economics. By 1930, a considerable amount of valuable information had accumulated, and this should serve as a very useful foundation for the thorough study of any problem that agricultural progress brings into greater prominence in the future. Even to-day much of this research could be expanded with profit, as, for example, the work on livestock improvement, but it is unfortunately limited by the departmental budget allotment, which, as a result of the general depressed economic situation, has been greatly reduced within recent years.

In a short article of this type, it has only been possible to give a very sketchy idea of the country, the people, and the type of agriculture. Only the more important aspects have been considered, but they should illustrate how widely different are the problems of the cultivator in Iraq from those of his Trinidad *confrère*. Various interesting memoirs and pamphlets have been published from time to time by the Department of Agriculture in Baghdad. The titles of some of the more recent of them are given in the appended list of references, in order that those interested in any particular problem may obtain greater details by applying for the appropriate publication.

PROBLEMS OF THE IRAQ CULTIVATOR.

Government Experiment Farm, Rustam, Baghdad.

SOIL EROSION.

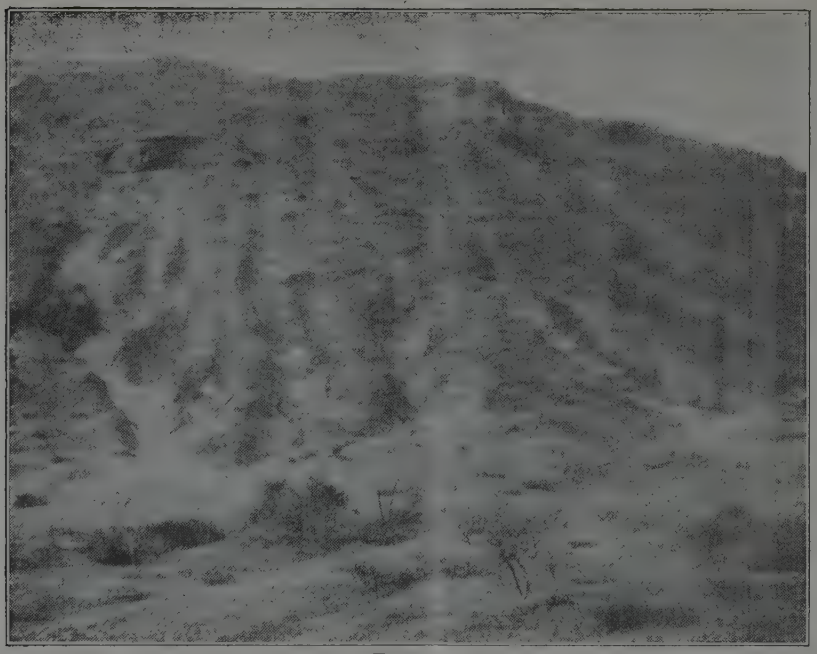

FIG. 1.

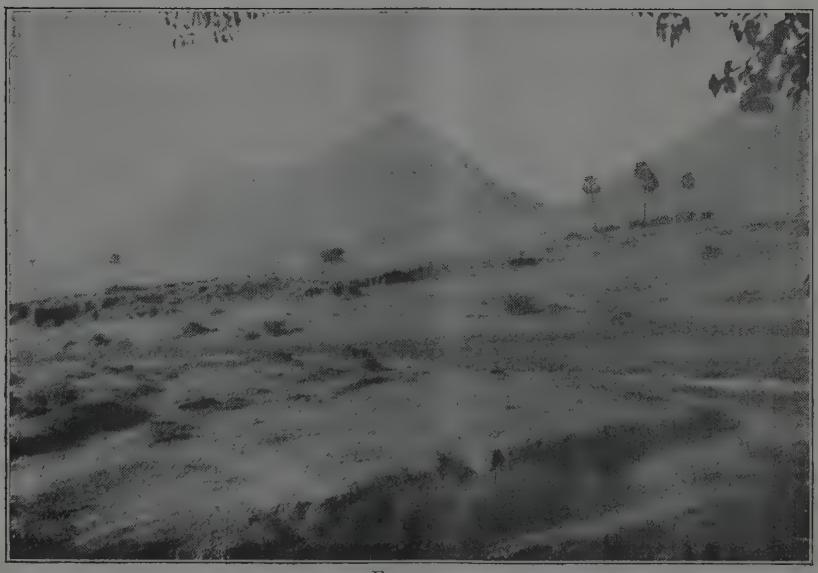

FIG. 2.

Some Publications of the Iraq Department of Agriculture (obtainable from the Agricultural Directorate, Baghdad).

(A)—Memoirs.

1. Alkali Lands in Iraq—a preliminary investigation by J. F. Webster. (*Times Press*, Bombay, 1921.)
2. Report on the Soil Survey of the Dialah Area—Right Bank—by J. F. Webster and B. Viswanath. (*Times Press*, Bombay, 1921.)
3. Dates and Date Cultivation of the Iraq, by V. H. W. Dowson. (*W. Heffer & Sons Ltd.*, Cambridge, 1921.)
   - Part I. The Cultivation of the Date Palm on the Shatt-al-'Arab (price Rs. 10).
   - Part II. The Results of an Investigation into the Yield of Date Palms on the Shatt-al-'Arab (price Rs. 5).
   - Part III. The Varieties of Date Palms of the Shatt-al-'Arab (price Rs. 10).
5. Further Studies of Alkali Soils in Iraq, by J. F. Webster, and B. Viswanath. (*Times Press*, Bombay, 1921.)
6. The Pests of the Date Palm in Iraq, by Rao Sahib Ramchandra Rao, with a supplementary note by A. Dutt. (*Times Press*, Basrah, 1922.)
7. A Preliminary List of Insect Pests of Iraq, by Rao Sahib Y. Ramchandra Rao. (*Times Press*, Bombay, 1921.)
8. A Report on a Varietal Test with Cotton on the Government Experimental Station, Baghdad, in 1922, by Roger Thomas and Kalidas Sawhney (*Empire Cotton Growing Corporation*, London, 1924).
9. Report on a Cultivation Experiment with Irrigated Cotton in Iraq, by Roger Thomas and Kalidas Sawhney. (*Government Press*, Baghdad, 1925.)
10. The Economics of Rice and Cotton Cultivation in the Dialah Liwah, by Khan Sahib A. A. Soofee. (*Government Press*, Baghdad, 1925.)
11. An Investigation into the Relative Utility and the Reliability of Various Methods of Comparing the Yields of Cotton from Experimental Plots, by Roger Thomas and Kalidas Sawhney (*Government Press*, Baghdad, 1925).
12. Linseed in Iraq, by D. D. Paterson (*Government Press*, Baghdad, 1929).
13. Note on Locusts in Iraq and the Control Measures adopted, by H. G. D. Rook. (*Government Press*, Baghdad, 1930.)
14. Sericulture in Iraq, by D. D. Paterson (*Government Press*, Baghdad, 1930).

(B)—Leaflets and Bulletins.

4. Names of Plants in Iraq, by Evan Guest (1929), (replacing original No. 4. Names of Field and Garden Crops grown in Mesopotamia).
12. Locusts (1926).
13. Sunn Pest (Ergaija) on Cereals in Iraq, by J. F. Webster and A. Dutt.
14. Aphids (1927).
15. Cultivation of American Cotton (1927).
16. Some of the Commoner Garden Pests of Iraq (1927).
19. Bunt Disease of Wheat and how to control it, by Evan Guest (1927).
20. Agricultural Statistics for Central Iraq, by D. D. Paterson (1929).
21. The Cultivation and Marketing of Linseed, by Evan Guest. (*Government Press*, Baghdad, 1930.)
22. Some Modern Methods of Field Experiment and their Statistical Analysis, by D. D. Paterson (*Government Press*, Baghdad, 1930).

SOIL EROSION.

THE two photographs reproduced opposite, for which we have to thank Mr. Anstead, lately of the Madras Department, form a most interesting illustration of the very grave dangers of soil erosion and the irreparable loss which may occur from the removal of surface vegetation and the destruction of the soil cover.

About ten years ago, in the village of Narsipatam, in the Godaveri district of Southern India, the restrictions which had hitherto obtained in the matter of grazing and wood-cutting on the hills behind the village were withdrawn. The result has been disastrous, for unchecked wood-cutting and unchecked grazing have, between them, removed every trace of vegetation, and the bare soil has suffered severely from erosion, as can be clearly seen in these photographs. Great gullies have been cut in the hillsides, and down these, in wet weather, the water pours with violence, carrying away with it the remaining surface soil (Fig. 1). Such damage is almost irreparable, for once the soil covering is gone, it is a matter of the utmost difficulty to replace it, nor can such replacement in any case be effected except at considerable expense.

So much is perhaps obvious, but it is worth while pursuing the matter a little further. The damage has not stopped at the removal of the surface soil on the hills, but in heavy rains, large quantities of coarser material from the subsoil are swept down the hillside, and this débris chokes the courses of the streams which should have carried off the storm water, with the result that these have spread over the surrounding country and covered the cultivated lands with a layer of sand and gravel, until, as may be judged from the second photograph, a considerable area has been completely ruined.

This damage has all been done in the very short space of ten years, and is no doubt an extreme case, but it serves as a very good instance of what is a serious problem in tropical agriculture. It has not always been recognised as such, but of late years those responsible for colonial agricultural development have come to realise its importance, and agricultural journals of to-day devote no little space to a consideration of the problems involved. A country cannot live on its capital, and a disregard of this principle has led to the complete ruin of large areas which once carried flourishing crops. The real danger lies in the fact that the damage is in most cases, slow and insidious; it is not often that it is so rapid and obvious as in this present case.

R. C. W.

TRINIDAD FUNGI

Copies (price 2*s*. each) of a list of TRINIDAD FUNGI compiled by C. A. Thorold can now be obtained on application to the Editor of this Journal.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Fuel values of Molasses and Bagasse.

A. J. Crees in a recent paper stated that of the 16 million gallons of final molasses at 87° Brix. produced in Queensland in 1929, about six were sold to distilleries, four were used as fuel, 3.5 were used as fertilizer or as food, and 2.5 were run to waste. Although its calorific value is 5380 B.T.U. per lb., therefore capable of evaporating 3.53 lb. of water per lb., in Java it was found by experiment that when burnt alone in special furnaces 1 lb. of molasses produced only 2 lb. of steam. Taking coal at 45*s.* per ton, and an evaporative capacity of 10 lb. per lb., this gives molasses one-fifth the fuel value of coal, or 9*s.* per ton or 0.7*d.* per gallon. It is sold to distilleries at 10*s.* per ton.

In Queensland in 1929 about one million tons of bagasse were produced from 3,581,205 tons of cane. With an evaporation of 2.3 lb. water per lb. of bagasse, and with coal at 10 lb. per lb., and costing 45*s.* per ton, 4.34 tons of bagasse are equivalent to one ton of coal. Hence the value of bagasse is 10*s.* 6*d.* a ton as fuel. In Louisiana and Cuba, the fuel value of bagasse is quoted at about 8*s.* 4*d.* per ton. In the form of "Celotex" or "Vazcane" board, the price is quoted at £6 to £9 per ton. If bagasse were utilized in some profitable manner or other and were substituted by coal, the existing grates in the boilers would have to be removed and some type of mechanical grate installed.

Take a factory crushing say 52.5 tons per hour, and using 66 per cent. steam on cane, and assume that a coal-fired boiler evaporates 5 lb. of steam per sq. ft. of h.s. per hour, then the h.s. required would be 15,500 sq. ft. For this mill the cost of replacement of the grates would be £5,425 without the cost of storage bins and conveyors. Chain grates would replace three men per shift, a saving of £54 per week, or £1,080 on a 20-week season. A four-weekly supply of coal would represent an outlay of about £4,232 or £21,160 on a 20-week season. Then the cost of moving coal from the dump to the stokehole, and interest on money paid out on coal, would increase the cost of coal from 42*s.* to 45*s.* Crude oil in bulk costs in Queensland on the average 104*s.* per ton.—(*Int. Sugar Jr.*, Vol. XXXIV, No. 398, p. 62.)

* * *

Jamaica Sugar-Cane Industry.

According to the Report of the Department of Agriculture, a revolution has recently been effected on large areas of sugar lands in Jamaica, by deep mechanical tillage, irrigation, the substitution of new canes for the old Jamaica cane and the rational use of fertilizers, mainly nitrogenous in character. Of the new canes, the Barbados seedling B.H. (10) 12 has now generally displaced the White Transparent as the standard cane of Jamaica. Of the hybrid canes from Java, P.O.J. 2725, P.O.J. 2727 and P.O.J. 2714 have made good on many cane lands in Jamaica in the order named. During the past year the Department has issued plants of P.O.J. 2878 to every estate in the island and to many small settlers.

The highest recorded yield from cane on an estate in Jamaica was from the Java cane, E.K. 28 in Vere, where this cane gave 78 tons per acre, which is about double the yield of the old estate cane. During the past decade the Hope nursery has issued over four million plants of new canes to growers all over the island. The result of this work can be seen in the complete revolution that has taken place in the varieties of sugar cane, which now enable far higher yields of sugar to be obtained than formerly.

Mosaic disease is steadily decreasing, as the planters are now paying much more attention to rogueing and the selection of healthy tops for planting; also they are increasing their areas in resistant varieties. The P.O.J. varieties are gradually superseding the Uba where this cane had been extensively planted to help to control mosaic. In some districts where mosaic disease was very prevalent it is now possible to grow again some of the more susceptible varieties where it was impossible to grow them before as they were badly attacked by the disease.

The standard varieties Ba. 11569 and B.H. 10 (12) continue to give good results and very large yields have been obtained from them this year. The general opinion of planters through the island is that B.H. 10 (12) is the better cane, both as plants and ratoons. S.C. 12/4 has given fairly good results but appears not to ratoon very well in heavy clay soils.—(*Facts About Sugar*, Vol. XXVI, No. 10.)

* * *

The Estimation of Reducing Sugars in Raw Sugars, &c., by the Pot Method.

This paper, by Hugh Main, B.Sc., is published in *The International Sugar Journal* for June, 1932, p. 213. The following abstract is taken from that source. The method described is of interest to sugar chemists in view of the advantages it presents, namely, a very high degree of accuracy, together with simplicity of manipulation, which render it eminently suitable for routine operation by inexperienced assistants. It is a volumetric method, involving an ingenious combination of known parts; yet the smallest percentages of invert sugar (even as low as 0.001 per cent.) in highly refined sugars may be determined by it. Fehling's solution is used with methylene blue as internal indicator. A boiling water-bath is employed for heating the several tubes containing the reaction mixture for a fixed time. A device that greatly increases the sensitivity of the method is the use of glass floats fitting closely into the tubes so as to prevent back-oxidation. Tables are given showing percentages of invert sugar, corrected for the influence of sucrose, from 100 to 0.3 per cent. For amounts below 0.3 per cent. a modified Fehling's solution containing potassium ferrocyanide and additional caustic soda is used. Great accuracy is attained in this low range. Tables are given covering the range from 0.8 to 0.001 per cent.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

New Source of Rayon found in Bagasse.

Using low-priced nitric acid, chemists of the U.S. Department of Agriculture have developed a process for making high-grade cellulose from bagasse, the waste from sugar-cane after the sugar has been extracted. These experiments, carried out by D. F. J. Lynch and M. J. Goss, of the Colour and Farm Waste Division of the Bureau of Chemistry and Soils, produced a higher percentage of high-grade cellulose from bagasse than any previous attempts.

From 250,000 to 500,000 tons of bagasse accumulate each year at the sugar-cane mills of the United States. Large quantities are used as fuel by the sugar mills, and for several years much has been used for manufacturing insulating building material, but the possibility that a higher grade of cellulose could be produced from bagasse led the chemists to experiment with it. The process increases the potential value of bagasse, and at the same time offers a new and steady source of raw material for the rayon industry. The Department regards the process as now developed to a point where commercial interests can work out the practical problems of manufacture.

The method, known as the nitric acid pulping process, consists of soaking the raw material in a weak nitric acid solution for several hours at a medium temperature, then heating it for an hour, and finally washing and boiling it in dilute sodium hydroxide to produce a soft, bleachable pulp. Cheaper supplies of nitric acid make the process commercially feasible. Some of its advantages as compared with older methods of processing bagasse are that open tanks are used instead of pressure tanks, and that it takes less heat, power, and time. —(*Ind & Engin. Chem.*, News Ed., Vol. X, No. 8, p. 102.)

* * *

Carbohydrates in the Banana.

A physiological study of the banana attempts to trace the movements and transformations of the carbohydrates synthesised during the growth of the plant. Analyses show that at the leaf edges, where the initial synthesis of carbohydrate occurs, there is a constant ratio of sucrose to inactive reducing sugar, with the former predominating, throughout the development of the plant. As the synthesised sucrose is transported down the vein of the leaf and through the leaf stalk, it is progressively inverted, until, at the peduncle, inversion is almost complete. No further changes are apparent until the fruit is reached. The majority of the reducing sugars here polymerise to form starch, while most of the remainder recombine to form sucrose. Very little free reducing sugar remains even in ripe fruit, the soluble carbohydrates present consisting almost entirely of sucrose. In the green fruit, also, starch is accumulated at the expense of the reducing sugars.—(*Brit. Chem. Abs., A.*, p. 824, 1930.)

The West African Oil Palm and the Production of Palm Oil.

There are about eighteen varieties of Elaeis guineensis, but these can be divided into three classes: (1) "Hard-shell" palm fruit; (2) "soft" or "thin-shell"; (3) exceptional types such as the "King" or "Sacred" palm and the perianth-fruited palm". Palm oils are marketed in two main kinds according to the amount of free acid present, this being chiefly caused by the method of extraction. The first type is known as high-grade or "soft" oil and the second as low-grade or "hard" oil. The high-grade oil is generally orange in colour, easily refined and decolourized, with a characteristic not unpleasant odour, and a soft pasty consistency at normal temperatures in Great Britain. The low-grade oil, on the other hand, varies from yellow to greyish-white or dirty brown, is difficult to decolourize, and is usually quite hard. In West Africa the high-grade oil is being tried as a motor fuel, for it is liquid at ordinary temperatures and no preliminary starting with petrol is needed. Even with oils high in free fatty acid no corrosion of the engine took place, and there was no clogging or perceptible carbonisation.

There are three chief methods of obtaining the oil; by boiling, fermentation, and mechanical extraction. The first and second methods are used by natives where there are no factories, while the mechanical extraction has been improved to such an extent that the oil may contain as little as three per cent. free fatty acid. Fruits which are over-ripe, or which have been bruised or have fallen to the ground, are unsuitable, and bruising during transportation to the factory must be avoided. Sterilization of the fruit to destroy naturally occurring enzymes is effected by heating the fruit under slight steam pressure, after which it is transferred to a digester consisting of a vertically arranged cylindrical vessel fitted with beaters, whereby disintegration of the oil cells is effected. It is then transferred to a centrifugal extractor containing a perforated basket having a well-fitting lid provided with a jointed steam pipe, whereby steam is injected into the mash while the centrifuge is being operated thereby facilitating the expulsion of the oil. The period of oil extraction is 15 minutes, and the oil is purified and freed from sludge and moisture by centrifuging in a machine of the De Laval type. In this way 85-87 per cent of the oil in the mesocarp can be recovered efficiently.

The chief obstacles to the success of plantations in West Africa have been (1) the difficulty of putting even a small factory in an area large enough to obtain a constant supply of pulp sufficient to keep it working two-thirds of the year, and yet be able to transport the oil to the coast for shipment: and (2) the unwillingness of the natives to work for money or goods for which they have no use or desire, and their native opposition and tribal jealousies.—(Jones—*Chem. and Ind.*, Vol. LI, No. 13 (1932), p. 269.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Market have ranged as follows (c.i.f. per cwt.) :—

	Foreign.	*Preferential.*
	s. d.	*s. d.*
26th May ..	4 6	9 3
2nd June ..	4 6	9 3
9th June ..	4 9	9 6
16th June ..	5 3	10 0
23rd June ..	5 6	10 4½
30th June ..	5 9	10 6
7th July ..	6 0	10 9
9th July (1931)	6 6	10 3

During the past month the market has been firm and there has been a welcome rise in prices. The President of Cuba has signd a Decree providing that the carry-over in Cuba at the end of the present year shall be shipped during 1933, and that the Cuban Export Quota for the U.S.A. next year shall be fixed at the actual amount shipped this year. This news, together with other favourable information, has resulted in almost daily advances in prices. It is hoped that this tendency marks the beginning of a return to a more reasonable level of prices.

* * *

RUBBER.—Quotations for Plantation Sheet have ranged as follows :—

	d.
25th May	1 13/16
1st June	1 3/4
8th June	1 3/4
15th June	1 3/4
22nd June	1 13/16
29th June	1 3/4
6th July	1 13/16
8th July (1931)	3 3/16

Prices have shown practically no change. The liquidation of several English firms interested in rubber made practically no difference to the market price. Rubber is now so cheap that it is unlikely that any factor could seriously depress the price still further. The imposition of the sales tax on tyres and tubes which came into force in the U.S.A. at midnight, 21st June, resulted in manufacturers making special efforts to increase their immediate production in order to avoid the tax. The consumption of rubber in June will probably show an appreciable increase on May, but it is expected that manufacturers' requirements will fall off now that this special demand has been met. If general conditions improve as a result of the Lausanne Conference and other international negotiations, rubber may be expected to share in the revival.

COCOA.—British Board of Trade returns for May show a further increase in deliveries for home consumption, which is for the five months, 3,158 tons ahead of last year and 8,514 tons ahead of 1930.

Prospective supply and demand position of cocoa does not warrant present low prices which do not appear to attract manufacturers for replenishing present consumptive reserves. Gold Coast exports for the first half of June amounted to 4,437 tons against 10,081 tons for the whole of June last year and 12,923 tons in 1930. New crops of Bahia and Sanchez are now being marketed, that is, June to September, and new West African crop will start in October. Accra prices for June deliveries started at 25*s.* 9*d.* and ended at 26*s.* 6*d.* with December at 25*s.* 10½*d.* Spot London Sales were on the basis of Trinidad 41-52*s.*, Venezuela 62-93*s.*, Costa Rica and Panama 28-31*s.*, Accra 27*s.*, Lagos 25-26*s.* and Fine Ceylon 60-62*s.* In Trinidad $6.25 a fanega is generally paid.—(*By courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

COTTON.—The following are the official spot prices in pence per lb., of the Liverpool Cotton Association :—

	American Mid.	*Egyptian F.G.F. Sakel.*
27th May ..	4.45	5.95
3rd June ..	4.10	5.60
10th June ..	4.09	5.55
17th June ..	4.31	6.05
24th June ..	4.41	6.30
1st July ..	4.65	—
8th July ..	4.87	—
10th July (1931) ..	5.05	7.85

The decline in cotton prices has been arrested—at least for the time being. Rainfall has been much above the average during June. Wet weather in May and June usually results in heavy boll-weevil damage. August will be the critical month, and it will not be surprising if prices show an appreciable improvement on their present level.

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TEA.—High quality tea has in no way lost its market, but general averages have fallen considerably. Averages on 22nd June included Ceylon 8.83*d.*, Indian 7.70*d.*, and Java 4.92*d.*, respectively, per lb. Lower prices have not stimulated sales. On the contrary, sales to the third week in June were considerably lower than for the corresponding period of last year.

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COFFEE.—Fine Jamaican made 200*s.*, a very special lot being sold at the high price of 206*s.* a cwt. Kenya sold at 88*s.* 6*d.* and Costa Rica, first size, 140*s.*, and second size, 120*s.* a cwt. Brazil has reduced No. 7 coffee from 12.7 dollars to 12.2 dollars but Santos No. 4 remains at 15.5 dollars. Home consumption to the end of May has been unsatisfactory.